

**PROCEEDINGS OF THE BIODIVERSITY CONFERENCE**

**Urban Biodiversity: Successes and Challenges: Introduction**

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Early in 2009, GNHS Council discussed how we might respond to International Year of Biodiversity, designated for 2010. We quickly agreed that the most appropriate theme for a city-based natural history society would be a focus on urban biodiversity: after all, it is still the case that too many people think of biodiversity as something you only find ‘out there’ in the countryside. So we felt that a conference discussing the range of biodiversity in towns and cities would be valuable. We were delighted when Jim Coyle of Glasgow City Council’s biodiversity team gave immediate support and we soon assembled a steering group comprising representation from GNHS, RSPB Glasgow, SWT, Glasgow Museums and GCC’s Biodiversity team. An early meeting agreed on the title: ‘Urban Biodiversity – successes and challenges’, because we wanted to describe and celebrate the successes achieved in conserving and enhancing biodiversity in Glasgow and other towns and cities, but also to discuss the challenges we still face in making further progress.

Timing was easy to decide on. Two factors settled the final weekend of October 2010. First, the United Nations Convention on Biodiversity meeting, planned to achieve agreement on new conservation targets was scheduled to end in Nagoya, Japan on Friday 29<sup>th</sup> October. Second, a new book, Co-ordinated by Glasgow Museums ‘Wildlife around Glasgow’ was due to be launched during the same week.

We decided early on a two-day meeting and that it should be over the weekend (the debate between weekend and weekdays for such a meeting is a tricky one, but venues are easier at weekends). The plan was to devote the Saturday to formal presentations: these would deal first with policy issues, achievements and benefits. We were very keen to ensure that the meeting would highlight the benefits of urban biodiversity to people. Saturday would also cover case histories, including single species, groups and unusual habitats, both by talks and by posters. We also hoped to entice

some high level political presence and were very pleased when Roseanna Cunningham, Minister of the Environment, agreed to open the conference. Sunday was to be a more practical, interactive day with the morning devoted to participative workshops with choices of topics, and the afternoon to excursions to interesting biodiversity locations within easy distance: we realised the riskiness of this in terms of weather and impending darkness on the last Sunday of October.

Over approximately monthly meetings from October 2009 the programme you see before you came together. We were very pleased by the response from our invited speakers: this seemed to be a meeting people wanted to contribute to.

What of the omens for success? First, ‘Wildlife around Glasgow’ was successfully launched on the Thursday before the conference, and a beautiful publication it is. Many congratulations to Richard Sutcliffe and his team. Second, despite gloomy reports during the week, the 190 nations meeting at Nagoya reportedly agreed on 20 new tough biodiversity targets to be met by 2020. It will be up to all of us to ensure that these are not just paper commitments. Third, as I came through campus to get ready for the meeting, a fox crossed my path – now a very common sight in the West End of Glasgow!

I’d like to thank all members of the conference steering group for their input over many meetings and e-mails; also, our funders, Glasgow City Council, the University of Glasgow and the Blodwen Lloyd Binns Bequest. I also acknowledge the honour bestowed by the Lord Provost in providing the Civic Reception which closed the proceedings. Most importantly, I must thank Richard Weddle whose tireless efforts made this conference possible.

**Urban Biodiversity: Successes and Challenges: Civic welcome speech**

Bailie Nina Baker

Glasgow City Council

Ladies, gentlemen and distinguished guests, it is my great pleasure to welcome you to this event, on behalf of the Lord Provost and people of the city of Glasgow. On the eve of your 160<sup>th</sup> anniversary, the Glasgow Natural History Society is to be congratulated for bringing together The University of Glasgow, RSPB,

Glasgow City Council, Culture and Sport Glasgow as was, now of course known as Glasgow Life, and the Scottish Wildlife Trust to hold this conference marking the International Year of Biodiversity.

With the vast majority of our nation's population living in urban areas, the quality of urban open spaces can have a significant effect on their attitudes to the natural world more generally. Professor Jim Dickson and others' ground breaking book on the plants in our city showed us how even apparently grotty brownfield sites are oases in otherwise less favourable urban environments and help the overall biodiversity of the city. This work has now been complemented by the recent fauna surveys by the volunteers of the Biodiversity in Glasgow project. With the continuing shortage of allotment plots in areas of high demand, the council's policy to help so-called Stalled Development sites become temporary community greenspaces will be welcome to many and it is to be hoped that the owners of such spaces see the benefits they can bring.

Your fascinating programme of talks looks at these wider issues as well as the micro-studies of particular environments, such as bings and wildlife corridors and of particular wildlife such as waterbeetles and epigeal invertebrates – do I assume this means our good friends the earthworms? (Audience response: No, these are surface-livers like slaters, millipedes and ground beetles). With more and more of our schools being not only Eco-schools but also gardening and food growing schools, I am sure our younger generation have a keen eye for Glasgow's biodiversity. And here in the university that enthusiasm is taken to the professional levels. You will be asked to consider if Glasgow is as green as its nickname, dear green place, but I am sure with the council staff, professionals and amateur enthusiasts' energy represented today, we can look forward to every effort being put towards improving the biodiversity in the future. So, I am pleased to provide this civic welcome half-way through your conference and wish you a successful and interesting event.

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## Urban Biodiversity: Successes and Challenges: Nature in the city

Roseanna Cunningham – MSP

Minister for the Environment - Scottish Government

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Urban environments are often thought of as human environments. After all, our towns and cities are home to over 80% of Scotland's population. But urban environments are so much more than this. Each town and city has its own unique mosaic of habitats and ecosystems. Gardens, parks, allotments, brownfield

sites, industrial sites, rivers, ponds and even graveyards all provide different niches for the thousands of species that share our urban landscape.

With all these different habitats on the doorstep it isn't surprising that urban environments are where most people have the opportunity to experience the natural world. But while this is obvious to us here today, it is not always so clear to other people living in urban environments – less than half of Scots get into the outdoors at least once a week. This is something that needs to change.

Being outdoors and around nature brings so many benefits. It can reduce stress and improve physical and mental health. In short it improves residents' quality of life. It is the Greenspace in our cities that can provide people with a quick and easy escape from the hubbub of city life. This is why SNH are promoting the Simple Pleasures these areas can bring. This is a new campaign aimed at getting the public out and about in their cities and introducing them to the wildlife within it. Over 20% of Glasgow is green space so the opportunities to experience nature really are on your doorstep.

As part of the Simple Pleasures campaign SNH have identified routes and suggested places to visit in and around Glasgow. Similar materials are being developed for other cities and I hope they become a useful resource for those of you working with the public. I understand that this conference is also linked to the publication of the book 'Wildlife around Glasgow', so the materials are out there that can help introduce people to the wonders of nature without the need for expensive equipment or extensive planning.

Of course, these opportunities only exist if the networks of green and blue space are properly managed. The ecological footprint of any city extends far beyond its boundaries and development pressures within the city limits can cause conflict. There is no easy solution to these pressures but planning and managing urban environments in the right way can have significant positive impacts. Connecting cities with the environment around them through habitat networks and limiting the impact of development on the surrounding ecosystems are vital parts to this. Climate change will add new pressures to the urban environment and working with the biodiversity that supports our ecosystems is one of the best ways of adapting and mitigating against its effects. We're promoting such policies through initiatives like the Central Scotland Green Network which is a priority under the National Planning Framework. This is already enhancing greenspaces, promoting healthier lifestyles, greater biodiversity, stronger communities and economic opportunity.

Many of you will be involved in making this a reality on the ground in many different ways. For example, Sustainable urban drainage (SUD) schemes help

mitigate against flooding and provide habitat for a variety of species. Promoting local food growing engages local people and helps reduce our overall carbon footprint. Householders can do their bit too by growing wildlife friendly plants, avoiding invasive non-native species and carefully composting what they can. When the impact of all these different initiatives is added together we end up with rich urban environments which benefit all the species that live in them. Not least the human community.

I've briefly touched on a few themes which I know you will be discussing in more detail over the next couple of days. As you might know, discussions have also been ongoing recently in Nagoya, Japan about the UN Convention on Biological Diversity. I know such high level debate can often seem far removed from the day to day delivery of biodiversity conservation and it is easy to be cynical about the process. But these discussions included a specific focus on cities and biodiversity. And while it's too early to have fully digested the outputs and what our response will be to it, I'm sure those aspects of the discussion in particular will be of interest to all of you.

Unfortunately, due to other commitments, I am not able to stay for the rest of the conference but from looking at the agenda and field trips I am sure you will have an interesting and productive two days.

(This is the formal version of the speech that the Minister delivered at the opening of the Conference).

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## Urban Biodiversity: Successes and Challenges: The next generation: environmental education with the RSPB

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An RSPB field teaching site was established at Kelvingrove Museum and Kelvingrove Park in 2007. It provides sessions for primary schools on woodlands, urban wildlife, birds, conservation and a sensory walk for infants.

All the sessions are based on the Scottish Curriculum for Excellence and involve active outdoor learning. The programme is agreed with the teacher before the visit and the quality of the service is evaluated by users and by the RSPB Education Officer. The RSPB field teaching scheme is a holder of the nationally accredited

Learning Outside the Classroom Quality Badge.

Around 2000 children visit the RSPB at Kelvingrove every year. Learning to appreciate the biodiversity in local parks encourages children to care for their own school grounds and gardens. A lack of knowledge about and experience of seeing wildlife is apparent in many Glasgow children making field trips a valuable part of school projects.

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## Urban Biodiversity: Successes and Challenges: Biodiversity on bings

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### ABSTRACT

The West Lothian oil-shale bings are important havens of biodiversity at both a local and a national (UK) level. They are examples of true primary succession and provide a refuge for locally rare species, both plant and animal, in an urban/ industrial/ agricultural landscape making them important to conservation and increased local biodiversity.

### THE SITES

The oil shale bings of West Lothian are piles of industrial waste; a by-product of Scotland's first oil industry in the 1850s. Historically they are of great importance (Harvie, 2010) and given their history it is perhaps not surprising that Greendykes and Five Sisters are now protected as designated Scottish Industrial Heritage Sites. Other bing sites are protected for more remarkable reasons. Addiewell North is a Scottish Wildlife Trust Nature Reserve, Oakbank is part of Almondell Country Park and all of the bings together make up a major habitat in West Lothian's biodiversity plan (Harvie, 2005a).

### THE FLORA

The West Lothian shale bings are of great ecological and scientific importance. They are examples of a distinctive and rare type of post-industrial waste that is unique within Britain. They are also examples of sites of primary succession. Primary sites are only found naturally on sand dunes, glaciers and volcanoes; all of which are very uncommon in Britain. Habitats within the bings vary from almost bare substrate to semi-natural grassland, heather scrub and pioneering birch woodland. Differences in the age and size of the bings, how they have been managed, available seed sources, substrate type and soil chemistry all contribute to the habitats and their vegetation. They provide refuges for a wide range of animals and plants that are under increasing pressure in the surrounding area from

farming and urban development. The diversity of plant species on the bings is considerable and the sites are home to more than 350 plant species (Harvie, 2005b). This is more than have been recorded on the Ben Nevis SSSI

Some of the bings support several plant species not found elsewhere in the county. *Buxbaumia aphylla* Hedw. is a rare moss in Britain that has been recorded in sizeable populations at Addiewell bing for more than 35 years. A small population of the montane lichen *Stereocaulon saxatile* is found on Addiewell bing and extensive colonies of three related and locally rare species *S. leucophaeopsis*, *S. nanodes* and *S. pileatum* are found on Philpstoun bing. Faucheldean bing is noted for colonies of stag's-horn clubmoss and alpine clubmoss (*Lycopodium clavatum*; *Diphasiastrum alpinum*), species that are more usually associated with montane habitats, and renowned for a diverse orchid population including broad helleborine, great butterfly orchid and early purple orchid (*Epipactis helleborine*; *Platanthera chlorantha*; *Orchis mascula*). On the plateaued summit of Greendykes a species poor calcareous grassland has established from self seeding species above the bare steep sides of the bing. Genetically distinct birch (*Betula pendula*) woodland has established naturally at the base of the tiny bing at Mid Breich, complete with many of the associated ground flora and bryophyte species of long established native woodlands. There are also exotics in the form of garden escapes that are well established on many bing sites. Opium poppies (*Papaver somniferum*) grow in profusion on more than one bing. Old elder trees growing on many of the bings are an astounding source of epiphytic lichen and moss diversity. Almost half of all the bryophytes that are recorded in Britain are present in the Lothians and shale bing habitats are identified as important to the bryophyte flora (Harvie, 2007).

## THE FAUNA

Locally rare animals are also often seen, especially on early morning visits. These include hares, red grouse, badgers, sky larks and common blue butterflies (*Lepus europaeus*; *Lagopus lagopus scotica*; *Meles meles*; *Alauda arvensis*; *Polyommatus icarus*). The bings are home to foxes (*Vulpes vulpes*), often seen in family groups, suggesting that many unobserved smaller fauna are also inhabiting the sites. Insect records from Addiewell bing include ringlet butterfly (*Aphantopus hyperantus*), very rare in central Scotland, and a first recording of ten-spot ladybird (*Adalia decapunctata*) in the county. Additional butterfly species recorded at Faucheldean include green-veined white, small heath and common blue (*Pieris napi*; *Coenonympha pamphilus*; *Polyommatus icarus*). Forty seven species of bird were recorded at Addiewell during 1997, including 30 species with permanent breeding territories and nine local habitat indicator species, such as the bullfinch, kestrel and yellowhammer (*Pyrrhula pyrrhula*; *Falco tinnunculus*; *Emberiza citrinella*) (Harvie, 2007).

## VULNERABILITY

The destruction and landscaping of shale bings is a severe threat to some of the rarer plant species, both locally and nationally. Of the 27 bings extant when shale extraction ceased in 1962 only 19 remain. Many of these are slowly being demolished and the continued, recent loss of sites like Philpstoun (to industry) and Niddrie (to housing development) can only be detrimental to the biodiversity of the county of West Lothian.

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## Urban Biodiversity: Successes and Challenges: Jupiter Urban Wildlife Centre

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Scottish Wildlife Trust's Jupiter Urban Wildlife Centre is situated in the middle of Grangemouth. The 4 hectares are leased from the chemical company Calchem. It is a fine example of land reclamation for nature conservation. In 1989, the chemical giant ICI approached SWT regarding setting up a demonstration wildlife garden on an abandoned part of their Grangemouth site. This area had been a railway siding. Upon acquisition, it was covered in a mixture of sparse grassland, scattered scrub and marshy areas. Jupiter was opened to the public in 1992.

Jupiter can be divided into three areas; wildlife gardens, habitat creation area and "wilderness woodland." The habitat creation area and wildlife gardens contain complex habitat mosaics often with unusual combinations of species, due to their interesting history, with some species having been

present when the area was wasteland, the deliberate creation of certain habitats and a combination of active management and natural succession over the succeeding years.

The wildlife gardens show ideas for creating wildlife friendly spaces. The habitat creation area consists of a number of habitats with artificial origins: wetlands, wildflower rich grasslands and small woodlands. The regenerated “wilderness” woodland is an excellent example of the potential of wasteland if allowed to develop on its own.

Thanks to the rich array of habitats and careful management work, Jupiter supports a wealth of biodiversity. Over 360 species of flowering plant have been recorded and attract many invertebrates. There are records of over 50 species of bird. Mammals are more rarely seen, although some species have been recorded. The ponds support breeding populations of amphibians.

Jupiter is also an important place for people. Curriculum linked education sessions, public events programmes, and volunteering are all popular. SWT’s partner organisation at Jupiter, BTCV Scotland, runs a Wildflower Nursery and a Green Gym. Secondary schools have been involved in exciting projects, designing and creating mosaics, murals and an outdoor classroom.

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## Urban Biodiversity: Successes and Challenges: Glasgow’s local biodiversity – the way forward?

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There were 24 attendees at the ‘Glasgow’s Local Biodiversity – the way forward?’ workshop, where people were asked to consider the following four questions:

1. Do you consider that the Glasgow Biodiversity Partnership is doing enough for biodiversity in the City?
2. What does your local greenspace need to make it good for biodiversity?
3. How can the Partnership best communicate and engage with ‘hard to reach’ groups?
4. What can *you* personally do to improve and enhance local biodiversity?

The results of the workshop, combined with a concurrent on-line questionnaire about biodiversity provision in the City (at [www.glasgow.gov.uk/biodiversity](http://www.glasgow.gov.uk/biodiversity)) will help shape the future direction of the Local Biodiversity Action Plan (LBAP), which is being updated. Due to time constraints, only questions 1-3 were considered and as the first two questions were linked the responses to them have been combined. The key responses are summarised here:

*Q. Do you consider that the Glasgow Biodiversity Partnership is doing enough for biodiversity in the City?*

*Q. What does your local greenspace need to make it good for biodiversity?*

‘More work needed in city centre areas. Everything happens north of the river.

Use the Commonwealth Games to showcase biodiversity to visitors. Need better biological recording, brownfield sites need surveyed. Need better co-ordination between conservationists and contractors. Make sure greenspaces are high quality. Push for more allotments in the City. Provide more awareness of sites that communities can work on. Provide biodiversity interpretation in local parks. Combat vandalism by encouraging community participation and schools involvement.’

*Q. How can the Partnership best communicate and engage with ‘hard to reach’ groups?*

‘Engage more with local industries and companies and make better business links overall. Raise biodiversity profile by establishing a volunteer system linking various organisations. Target unemployed people at job centres to encourage volunteering – advertise. Give youth group talks and activities. Use social media such as facebook. Think about unusual media like drama groups, art and music groups – put on a biodiversity theatre production. Link more with secondary schools. Wider community work with different ethnic groups, taking ‘whole’ communities out on site. Use radio shows, places of worship and other venues to promote biodiversity.’

The update of the LBAP will include the development of a Community Engagement Plan which will allow local people and interest groups to help set local targets for biodiversity, and to consider the topics and queries above. The programme of Local Nature Reserves (LNRs) designation and development will help achieve many of the concerns raised. Linn Park on the south side, will soon be designated as an LNR. Darnley Mill is a proposed LNR, also on the south side of the City. There are LNR leaflets which are designed to raise awareness of biodiversity and the importance of these sites for people and nature. There are already a number of volunteers helping at our LNRs and it is hoped these numbers will increase in the years ahead.

New ideas such as using drama and social media to raise awareness of biodiversity could add a different strand of actions to the updated LBAP.

There are clearly a number of issues which have been raised by discussion within the Workshop and opportunities for these issues to be addressed by the new LBAP and any related policies and strategies.

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## **Urban Biodiversity: Successes and Challenges: Connecting habitats and communities workshop**

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Urban environments are becoming increasingly valuable habitats for a wide variety of species. As these areas are associated with large populations of people there has to be a balance between protecting valuable habitats and providing suitable housing and related industry. Local communities have a considerable amount to offer and gain from being involved in improving their local area for wildlife.

Froglife's Living Waters projects are working in London and Glasgow to engage with local communities and help complete habitat creation and restoration work on standing open water habitats. This work is being carried out in partnership with Glasgow City Council and relevant London Boroughs, and is supported by local volunteer and 'friends of' groups from different urban parks. To promote sustainability of habitat work, communities are involved where possible on site and opportunities are provided to teach survey and practical conservation techniques.

Froglife designed the workshop 'Connecting Habitats and Communities' to promote the importance of community involvement and raise awareness of enhancing habitats and creating essential wildlife corridors to increase connectivity between sites.

The workshop commenced with a short presentation introducing Froglife's work followed by an interactive discussion with the audience. Eighteen people attended the workshop and were split into four groups. The groups were provided with a map of an urban site featuring a park, a school, ponds, hedgerows, ditches and allotments. A role-playing exercise was completed with each attendee being assigned a role as a different stakeholder with an interest in the local area. The character briefs included: a Head Teacher of the local school, a Council Park Manager/ Biodiversity Officer, and a representative from each of the following groups: a Friends of Group, a Local Natural History Society, a Wildlife Charity Officer and a Local Allotment forum.

The groups held discussions in which each person gave suggestions from their point of view to provoke discussion and develop ideas for the area. This included how they would improve the selected site for wildlife, a proposed methodology for completing this work, and suggestions on how to involve members of the community.

There were many aspects to cover in the session, but each group was able to provide one suggestion from their discussion to share with the rest of the audience. Groups had also written down a number of other ideas. Some similar themes emerged, as well as new initiatives for this type of urban site.

Examples provided from the group discussions are shown below:

- Pond creation and management - connecting and improving habitats including areas beyond the site boundary.
- Conducting surveys of flora and fauna and mapping what is present to improve records.
- Encouraging more local people to assist and gain new skills.
- Training and sharing knowledge across different community groups on wildlife friendly gardening, vegetable growing, pond creation and surveying.
- Working with local groups such as allotment users to save resources, for example water and tools.
- Improving amenity grassland with wildflower meadows. Connecting habitats and encouraging communities to get involved through planting and enjoying the aesthetic value of wildflower meadows. Creating more hedgerows to connect habitats.
- Writing a wildlife column for a local newspaper to share news e.g. nature diary or update community with recent work completed.

To conclude the workshop the site for which participants had made their suggestions was revealed as Foots Cray Meadows in South London. Work completed by Froglife in the area was also discussed, including enhancement of one pond and the creation of eight new ponds. Work is also taking place to improve the surrounding terrestrial habitats not only for amphibians and reptiles but also wider biodiversity. Friends of Foots Cray Meadows have been involved with Froglife and support the habitat improvement work.

The workshop was presented by Eilidh Spence and Sam Taylor from Froglife. Eilidh is the Glasgow Living Water Project Officer and can be contacted by email at [eilidh.spence@froglife.org](mailto:eilidh.spence@froglife.org), or 01413390737. Eilidh is based at the University of Glasgow in the Graham Kerr Building. Sam is Froglife's Head of Communication and deputy CEO and is based at Froglife's headquarters in Peterborough. Sam can be contacted by email at [sam.taylor@froglife.org](mailto:sam.taylor@froglife.org).

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## Urban Biodiversity: Successes and Challenges: Excursion to Bingham's pond

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Bingham's Pond (Fig. 1), situated just off the busy Great Western Road, Glasgow, was once a popular skating and boating pond. It became the subject of complaints by local residents concerning the rundown state of the pond and swan droppings making the path slippery and the water dirty. The large numbers of mute swans were dependent on bread as the pond supported almost no natural vegetation.



**Fig. 1.** Bingham's Pond

In consultation with the local Community Council, it was decided to naturalise the pond to provide a more attractive place for the local people to enjoy and to enhance the biodiversity. It was hoped that by providing suitable habitat, a pair of breeding mute swans might be attracted to the pond and so control the large numbers of non-breeding swans, thus alleviating the perceived problem of the droppings and water quality.

A steering group from the local community was set up to carry the project forward. In February 2003, the water level was lowered and many of the waterbirds flew off. 55 swans remained. These were rounded up and transferred to Hogganfield Loch, NE Glasgow. Work then started to create two islands and a shallow shelf area around them and most of the perimeter of the pond.

Over 7000 plants of over 20 species were planted. Wildflower mixes were seeded on the islands and the

edge of the pond above the water level. The bulk of the plants were collected elsewhere in Glasgow. The plants were therefore of local provenance and importantly brought in aquatic invertebrates among the roots, which 'inoculated' Bingham's Pond, thus enhancing the biodiversity of the site. A frog ramp was built to enable young common frogs to reach suitable habitat for feeding and hibernation and interpretation boards were erected.

In the first year after naturalisation, mute swans, mallard, tufted duck, moorhen and coot bred. Surveys of the aquatic invertebrates of the pond before and after naturalisation, has revealed a large increase in the number of species present in the pond.

As part of the Urban Biodiversity Conference 2010 an excursion to Bingham's Pond was held at 2pm on 31<sup>st</sup> October. This session was attended by 14 people and blessed with quite good weather. Sheila Russell from Glasgow City Council led the group around the pond explaining the enhancement process and work completed on site.

The excursion was concluded with examples of pond restoration and creation work in Glasgow through Froglife's Living Water Project, provided by Project officer Eilidh Spence. Examples included restoration work at Newlands Park, Dawsholm LNR, and Alexandra Park and also pond creation work at Dams to Darnley Country Park and Windlaw Marsh. Proposed future work and the expansion of the project into North Lanarkshire were also discussed.

The pond enhancement work at Bingham's Pond through Glasgow City Council will continue to be used as a demonstration site. The aim is to encourage landowners and stakeholders to care for standing open waters and contribute towards local biodiversity action plans to protect these valuable habitats for wildlife.

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## Urban Biodiversity: Successes and Challenges: Posters - Bumblebee Conservation Trust

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Urban habitats provide valuable nesting opportunities and forage resources for bumblebees. Six species are commonly found in gardens, providing a significant, free, pollination service for fruit and vegetables, and of course wildflowers. Planting and management of bumblebee-friendly flowers in parks, gardens, orchards

and other areas helps deliver substantial benefits for this crucial group of 'keystone' pollinators. The first British record of the tree bumblebee *Bombus hypnorum* was in 2001 on the Hampshire/Wiltshire border (Fig. 1). A population quickly became established and since 2007 the range has rapidly expanded to cover much of England. The species has not yet been recorded in Scotland. A distinctive species often found in urban areas, recording by the public is encouraged to monitor this colonisation event.



**Fig 1.** Tree bumblebee (*Bombus hypnorum*)  
Photo credit: Bumblebee Conservation Trust.

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## Urban Biodiversity: Successes and Challenges: Challenges in Glasgow's urban woodlands

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Glasgow's woodlands are diverse in location from stand-alone woods to park woodlands and Local Nature Reserves, yet whilst there are differing types of woodlands across the city many of the mature woodlands are not diverse in either species or age structures. Glasgow City Council utilises sustainable silvicultural management systems to ensure woodland cover in perpetuity whilst increasing biodiversity through developing native species elements and age

structures of woodlands. There are many challenges to successfully meet the woodland management objectives, including managing woodlands as a social resource as well as an environmental resource.

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## Urban Biodiversity: Successes and Challenges: Local nature reserves in Glasgow

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### INTRODUCTION

The City of Glasgow, commonly known as the 'dear green place', has seven Local Nature Reserves (LNRs). What is meant by the term LNR? Put simply, LNRs are:

- Statutory designations made under the National Parks & Access to the Countryside Act 1949.
- Special places which are rich in wildlife, generally
- Generally, readily accessible and suitable for people to visit and enjoy.

The LNRs - at Garscadden Wood, Dawsholm Park, Robroyston Park, Hogganfield Park, Cardowan Moss, Bishop Loch and Commonhead Moss - were declared by the land owner of all seven sites, Glasgow City Council (GCC). In declaring these sites, GCC aims to:

- Protect them from unsuitable developments
- Manage and enhance the habitats to help biodiversity flourish
- Improve public access
- Help people understand and become more aware of the importance of the LNR
- Encourage community participation and volunteering.

### Description of Glasgow's Local Nature Reserves

All seven LNRs are located north of the River Clyde, generally on the edge of the city's built-up area, from Garscadden Wood in the west to Commonhead Moss in the east (Glasgow City Council 2008). Taking each in turn:

**Garscadden Wood** was declared a LNR in 2006. It is one of Glasgow's oldest semi-natural woodlands in the city. Its main attractions are its bluebells *Hyacinthoides non-scripta* in late spring and the purple hairstreak butterfly *Neozephyrus quercus*, only one of three places where they can be found in the city.

**Dawsholm Park** consists mainly of policy and plantation woodland and is important for its woodland bird populations. It was designated as an LNR in 2007.

**Robroyston Park**, declared in 2006, plays host to grassland, wetland and woodland habitats. These prove

ideal for amphibians, dragonflies and damselflies and a host of birds.

**Hogganfield Park** was the second LNR to be declared, in 1998. It is a great place to see birds, particularly wildfowl, with winter visitors such as whooper swan *Cygnus cygnus* being a speciality. It is also good for summer migrants and has a good range of butterflies.

**Cardowan Moss**, also declared in 2006, consists of relatively new plantation woodland with a series of ponds and a relict raised bog. It is good for woodland birds, damselflies and dragonflies and amphibians.

**Bishop Loch**, the first LNR in the city (1995), was established as a direct result of local people protesting against an open cast coal mining proposal in the vicinity of the loch. They felt sure it would destroy what they described as their "local nature reserve". The planning application for the mining was refused by GCC and thereafter by the Scottish Office, following an appeal and public inquiry. Ironically, the area eventually declared doesn't include any of the actual loch but does include the marshy areas adjoining the loch plus a woodland plantation that plays host to typical woodland birds.

**Commonhead Moss**, the latest LNR declared in 2009, includes much of the largest raised bog in the city. It is particularly important for its butterflies.

It is worth noting that there are a number of other wildlife sites in the City that are protected and, in some cases, managed for wildlife, e.g. Possil Marsh SWT Reserve. GCC has recognized these sites in its City Plan (Glasgow City Council 2009).

**Management of Glasgow's Local Nature Reserves (LNRs)**

Generally, each LNR has a steering group of officials, interested agencies and local people. They approve, monitor and amend the Management Plans that were prepared as part of the consultation procedure with SNH. Works on the ground are funded by Council budgets, Landfill Credits and grants; and are implemented by council staff, contractors, volunteers and local people including school children.

**Examples of Management Works**

*Dawsholm Park Local Nature Reserve*

This LNR consists mainly of policy and plantation woodland and is important for woodland birds. However, the woodland was being smothered by rhododendron *Rhododendron ponticum* resulting in very little regeneration. This resulted in projects being developed, with the support of Forestry Commission Scotland (FCS) and local residents, aimed at bringing the woodland back to good health for wildlife and people. Specific projects included:

- Woodland thinned
- Rhododendron removed
- Footpaths improved and a new fence erected
- Wildflower meadows created
- Highland cattle introduced
- Interpretation/information provided
- BBC Autumn Watch and other events held.

Further improvements are planned, including:

- The planting of thousands of trees.
- The erection of woodcrete bird nest boxes.

*Hogganfield Park*

The LNR was declared primarily due to the importance of Hogganfield Loch, however, a number of works have been undertaken to widen the scope and range of habitats and species in the LNR - this is an ongoing project that was first started to demonstrate what could be done in the context of the evolving Biodiversity Plan for the city. Specific projects at Hogganfield Park LNR include:

- Wetlands/ponds created
- BBC SpringWatch and other events held
- Information/interpretation boards erected
- Wildflower meadows created/managed
- Rhododendron removed
- Bird perching posts and loafing pontoon installed
- Loch edges improved.

Further improvements are planned, including:

- Naturalisation of the loch edge at the existing car park
- Creation of a bird viewing and feeding platform.
- Enhanced public access.

The works listed above were undertaken by groups such as BTCV, Scottish Wildlife Trust, Score Environment, BBC and GCC utilising contractors, council staff, volunteers and local school children.

**Way Forward**

With the current economic crisis and the likely reduction in public sector funding for LNR type work, what can be done to ensure that people can continue to have access to nature on their doorstep?

I would suggest that this can be achieved at both the macro and micro scale.

Firstly, at the macro scale, partnership working is key. For example, through partnerships established with:

(i) *Local Groups*

These include groups such as Froglife, the RSPB Glasgow Local Group, and BTCV.

(ii) *Forestry Commission Scotland (FCS)*

The Council has reached agreement, in principle, for the FCS to take over the day-to-day management of a number of woodlands in the City, including 3 LNRs - Garscadden Wood, Cardowan Moss and Bishop Loch. (Glasgow City Council 2009).

(iii) *Gartloch-Gartcosh Project*

This project covers an area stretching from Hogganfield Park LNR through to Drumpellier Country Park in North Lanarkshire and includes Cardowan Moss, Bishop Loch and Commonhead Moss LNRs. A consultants study (Land Use Consultants 2008), commissioned by a host of agencies, recognised that the area is potentially of national importance for wildlife. This Strategy - the Gartloch-Gartcosh Green Network Strategy - has been well received and a number of agencies have already progressed a variety of projects; e.g. see Section 4 in relation to

Hogganfield Park LNR. It is important that the agencies that commissioned the consultants' report continue to commit to its implementation.

Whilst these projects and ideas are crucial to ensure the future of LNRs at the macro scale, the future of 'nature' in the City could be said to be in the hands of local people. Why local people? At the 'micro' scale, they already manage a considerable 'green' resource – gardens and allotments. With minor changes to their management, there could be huge benefits for nature without any cost to the public purse. As a result, green corridors would be created, just like the large scale habitat works proposed through the Gartloch-Gartcosh Project, but on a smaller scale.

Gardens play host to a whole range of wildlife and are key to engaging with current and future generations. Even small spaces can be managed for wildlife and this in turn could awaken an interest and quest for knowledge that can only benefit us all. Having experienced what can be attracted to their garden many people will take more of an interest in their LNR or wildlife site. Who here at today's Conference hasn't already taken that step? This leads me to my final point. If you care about wildlife or nature you can all make a difference. If you care about Glasgow's wildlife I would ask you to consider whether you would join or help create a 'Friends of Glasgow's Local Nature Reserves' whose aim would be to lobby and raise funds for Glasgow's wildlife whether at the macro or micro scale. Thank you and remember Glasgow's Wilds Better!

#### ACKNOWLEDGEMENTS

Much of the work in relation to LNRs in the City is unlikely to have happened without the support and dedication of the biodiversity & ecology officers in Glasgow City Council.

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## Urban Biodiversity: Successes and Challenges: Health-promoting environments – is good greenspace good enough?

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In 2009/2010 greenspace Scotland worked with NHS Health Scotland, Scottish Natural Heritage, Glasgow City Council and the Dundee Environment Partnership to develop and publish what is known as an outcomes framework showing how work to create, maintain and manage greenspace can contribute to the delivery of national and local health priorities (greenspace Scotland, 2010). An outcomes framework is a linked series of logic models which draw on available evidence to demonstrate the connection between planned actions and desired outcomes. This knowledge and approach can help practitioners to better make the case for investing time and resources into greenspace and to improve the planning and evaluation of what we do 'on the ground'.

Our research project used eight pieces of greenspace work and a review of existing research literature. The work was set in the context of national health priorities which are expressed and interpreted at a local level. We considered three outcomes - increased levels of physical activity; enhanced mental health and wellbeing; reduced health inequalities - which partners felt could easily be linked to greenspace. These were a synthesis of outcomes contained in the Dundee and Glasgow Single Outcome Agreements.

This work allowed us to draw a series of important conclusions:

**People need to use and/or value greenspace to derive the maximum health benefits.**

Most of the health benefits reported in the research require either direct interaction with the environment or some level of positive personal response to the environment.

**Simply creating or preserving greenspace is not enough.**

Not all greenspace is beneficial to health – poor spaces can be detrimental to mental health and wellbeing and deter people from taking physical exercise; they can become the places which communities avoid rather than the places where they come together. The potential health benefits of greenspace are only realised if we have the right distribution and mix of spaces.

**Appropriate management is crucial.**

The potential for delivering health benefits is

dependent on how we manage the spaces that we have. Inappropriate or inflexible management approaches can often exclude people from spaces and fragment communities.

**Promotion of healthy uses of greenspace is also essential.**

All spaces need some form of active management and promotion of use (even if this is as simple as encouraging local people to adapt spaces to their own uses) - but it goes further than this. Particularly when we look at tackling health inequalities, many of our 'target audience' do not have a culture of using spaces. In such cases, it may be necessary to combine appropriate management of spaces with targeted support for use (from simple publicity and promotion through to behavioural change programmes such as health walks or gardening clubs).

**If we are genuine about tackling inequalities, our resources and actions have to be targeted.**

Simply improving greenspace (even in ways that are designed to provide healthy environments) will not reduce health inequalities. In practice, what is likely to happen is that those who are most disposed to use greenspace will use it more while many of those experiencing health problems which might be addressed through greenspace will not. This will widen health inequalities. There is a need, therefore, to actively target our actions either on specific geographical areas; specific communities or people experiencing specific health conditions.

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**Urban Biodiversity: Successes and Challenges: Glasgow's water beetles**

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**INTRODUCTION**

Water beetles are a well-recorded freshwater group in Britain despite lacking the charisma of dragonflies and the angling interest of mayflies and the like. The conference on urban biodiversity held by the Glasgow Natural History Society in October 2010 provided the stimulus to assess their status in the area.

Water beetles cannot be precisely excised from beetles as a whole. Coleoptera are divided into two major

groups, the Adephaga and the Polyphaga. Within the Adephaga the name "Hydradecephaga" has been coined to distinguish diving beetles and related species from the ground beetles in the Carabidae. This works fairly well so long as one ignores the fact that many ground beetles are confined to aquatic emergent vegetation or to the water's edge. The Polyphaga are more difficult, with even the major family the Hydrophilidae including some species mainly living in dung, often a wet habitat but not one usually worked with the pond net! The problem is acute for the leaf beetles (Chrysomelidae) and weevils (Curculionidae and Eirrhinidae) that live on wetland plants, as sometimes the host range is quite diverse and may even include trees! The acid test applied here is whether the beetles are more likely to be encountered in the pond net wielded by an aquatic coleopterist than in a sweep net swung by a dry-shod coleopterist.

This paper is in two parts, an assessment of the records available from the national recording scheme and a description of a survey of sites in and around Glasgow in 2010.

**RECORDING AROUND GLASGOW UP TO 2010**

Information was extracted from the national recording data-base for the twenty 10 km squares NS44 in the south-west corner to NS87 in the north-east. This generated 1,644 records of 141 species, the majority from the vice-county of Lanarkshire, with small contributions from the vice-counties of Ayrshire, Renfrewshire, Dunbartonshire, and Stirlingshire. These beetles belong to fifteen families, dominated by the diving beetles in the Dytiscidae (Table 1).

Although 24 species have not been recorded in the area since 1979, 16 were last recorded in the 1980s. Eleven of the latter are typically associated with running water, leaving only another eleven running water species in the list of 101 species recorded from 1990 onwards. However several water beetles specialising in pond habitats have become established in the Glasgow area over a similar period.

The following examples of some species in decline and some on the increase serve to illustrate the range of habitats that can be occupied.

***Noterus clavicornis* (De Geer)** This species is usually referred to as "The Large *Noterus*" because the name *clavicornis* has also been applied to the smaller, flightless *N. crassicornis* (Müller), which is very rare in Scotland. The earliest Scottish record is a little uncertain but by 1946 *N. clavicornis* was in the garden of the greatest proponent of water beetles, Frank Balfour-Browne, in Dumfriesshire and it was first found in Kirkcudbrightshire in 1949. Roy Crowson (1987) reported it in the Glasgow area in Possil Loch in 1985, the same year that the author found it for the first time in Ayrshire. Subsequently it has spread over more of western mainland Scotland (an early record from Raasay was spurious) and was in 2010 found for the first time in the Borders in a well-recorded site in

Roxburghshire. The noterine diving beetles differ from the dytiscid ones mainly in that their wireworm-like larvae live attached to roots and rhizomes of flote-grasses and bogbean, renewing their air supply through their posterior spiracles from aerenchymatous plant tissue, whereas the dytiscids live freely. Consequently noterids are typical of vegetation rafts though *N. clavicornis* can be common among vegetation in ordinary ponds, including in 2010 Durrockstock, Gartcosh, one of the M77 balancing lagoons at the Mearns Box, the Phoenix Industrial Estate, and Robroyston.

***Agabus congener* (Thunberg)** This is a scarce dytiscid diving beetle typically found in small hard-bottomed pools on peat. It persists in the Glasgow area on Lenzie Moss having first been reported in the Glasgow area in Robroyston Bog by the Reverend Hislop (1854).

***Rhantus suturalis* (Macleay)** The name “supertramp” has been used for this species (Balke *et al.* 2009) respecting its remarkable range, from Ireland to New Zealand. Its ancestry, based on mitochondrial DNA, indicates that about 1.5 million years ago it was an endemic of New Guinea mountains. Now it can be found in a great range of still water habitats north to Caithness. One specimen was found in a newly created pond at Cardowan in 2010: the only earlier record, and there is potential confusion over the names it has received, is from the 19<sup>th</sup> Century (Young 1856).

***Hydroporus ferrugineus* Stephens** A major centre of biodiversity for water beetles is part of the Australian outback where each isolated pocket of subterranean water has its own endemic diving beetle species (e.g. Watts & Humphreys 2009). The northern European fauna is more restricted with only *H. ferrugineus* being truly subterranean though, unlike many subterranean species, it retains eyes. The larva, which is unusually pale, was described from the Speedwell Cavern by Alarie *et al.* (2001). *H. ferrugineus* is often found in wells and can occasionally be pumped to the surface (Young 1980). Professor Crowson’s collection, in the Hunterian Museum, has a specimen of *H. ferrugineus* found by Mr H.D. Slack at 384, West George Street, Glasgow in December 1957. This address no longer exists, most likely lost beneath the motorway, but the possibility remains that this species survives in spring systems among the Glaswegian drumlins.

***Hygrotus nigrolineatus* (von Steven)** This beetle was first found in Britain in a pit used for gravel extraction in East Kent in 1983 by Ron Carr (1984). It subsequently spread through England as far north as Northumberland by 2004. A single specimen was taken by Craig Macadam in his Glasgow pond survey in May 2010 in a recently excavated pond at Robroyston (NS629683) (Macadam & Foster 2010). This beetle lives on an exposed substratum and cannot tolerate the presence of vegetation.

***Helophorus tuberculatus* Gyllenhal** This rare species is 3 mm and black, resembling a fragment of chareoal (Angus 1992). It lives on wet moorland that has been burnt, its principal population in Britain being on the North Yorkshire Moors, where the heather is managed by burning. Specimens dated from 1910 to 1915, from

Drumpellier, Coatbridge, can be found in many entomological collections throughout Britain. These were mainly supplied by W.J. M’Leod, who, according to Balfour-Browne (1958), visited the site along with the original discoverer, G.A. Brown, and Anderson Fergusson in 1911. The near extinction of this species might be related to the loss of steam power, which would have ensured frequent burning of moorland neighbouring railways.

***Macrolea appendiculata* (Panzer)** Most reed beetles have showy adults living above the water on emergent vegetation, in particular reeds and bur-reeds: their larvae, like those of the *Noterus*, depend on aerenchyma of aquatic plants for their air supply. Members of the genus *Macrolea* are amongst the most aquatic of all beetles, living below the water in all stages of the life-cycle unlike the majority of beetles, which pupate out of the water. The sole record of *M. appendiculata* stems from another specimen in Professor Crowson’s collection, taken by his wife Betty in Loch Libo, Renfrewshire on 29 April 1967. *M. appendiculata* has as its host plants alternate water-milfoil (*Myriophyllum alterniflorum*) and fennel pondweed (*Potamogeton pectinatus*). According to Monahan and Caffrey (1996), working in Irish canals, this species prefers fennel pondweed when both potential hosts are available. Further attempts to find the *Macrolea* in Loch Libo have been unsuccessful, and the fennel pondweed, which was plentiful up to 2004, could not be found in 2008, possibly because of eutrophication. *Macrolea* appears to have been lost from Milton Loch, Kirkcudbrightshire, where it was abundant in 1996, and Loch Leven, Fife, where it was found in 1933: these lochs have suffered from algal blooms that would have destroyed suitable host plants.

***Eirrhinus aethiops* (Fab.)** This is a relatively large (5–7 mm long) black and shining weevil that looks as if it may have fallen in the water by accident when caught in the pond net. It lives on bur-reed (*Sparganium erectum*) and some sedges. Morris (2002) noted that it is usually rare and found north from north-east Yorkshire, though not in northern Scotland or on any of the islands. Pitfall trapping on exposed riverine sediment has established its presence in Wester Ross, Morayshire and East Inverness-shire (Eyre *et al.* 2000). Crowson (1971) recorded it from Loch Libo, where the author found it again on 31 May 2008.

## THE 2010 SURVEY

The author’s 2010 survey of ponds and similar habitats covered 37 sites generating 426 records of 76 species (Table 2), adding six species to the overall list. In Table 1 the other two species recorded in 2010 were from Craig Macadam’s survey, *Hygrotus nigrolineatus*, described above, and *Haliphus fulvus*.

Apart from the *Hygrotus nigrolineatus* two other species are rated as Nationally Scarce on a GB-wide basis in a recent analysis (Foster 2010). *Rhantus frontalis*, represented by one specimen at Cardowan, is known in Scotland elsewhere from Angus in 1933,

Ayrshire, most recently in 1911, Fife, most recently in 1961, Stirling and West Perthshire in the 19<sup>th</sup> Century, West Lothian in 1985, and since 2005 along the Solway coast. Earlier records for the vice-county of Lanarkshire are by Magnus Sinclair and the author from Carstairs Kames (NS957472) on 8 April 1977 and by the author from Coalburn (NS8035) on 25 May 1981. The Kames provided a more typical habitat for this species, sparsely vegetated water over sand, than the new Glasgow site in a shaded tussock fen. This species overwinters out of the water (Galewski 1963) and probably flies to seek ponds suitable for breeding in the spring. The other Nationally Scarce species, *Helophorus granularis*, was common in the marsh where *R. frontalis* occurred. This is a species of “vernal swamps” (see Balfour-Browne 1958) and occurs, scattered across the British Isles, in the micropterous form *ytensis* Sharp, the wings of which are reduced in size but possibly not entirely incapable of flight.

On the basis of these GB-nationally Scarce species the marsh at Cardowan rates as the site with the greatest conservation status in the survey. A system that assesses conservation quality of the basis of all species present was developed by Foster & Eyre (1992). It was based on counts of ten km square records converted to scores in a geometric series from 1 for the commonest species, then 2, 4, 8...etc. up to the rarest species. The scores for southern Scotland used by Foster & Eyre (1992) are out-of-date, being based on considerably less records than are currently available and on a more limited suite of species than is currently recorded. New scores were developed (Table 2) based on counts of each species in the twenty 10 km squares of the search area used for Glasgow as available in the national recording scheme data-base, supplemented by records from the Chrysomelidae atlas (Cox 2007). These counts were used to assign each species a score from 1 to 5 on an arithmetic scale (1, 2, 4, 8, 16 if geometric) that then could be used to produce an aggregate quality score and a mean quality score for each site. The mean score should be more reliable than the aggregate score or the total number of species as it reduces the impact of variable recording effort.

Sites in Table 2 are ranked in order of the mean quality score. Bingham's Pond, beside the Pond Hotel on the Great Western Road, scores highest. This site, a typical Victorian Park pond with hard edges and many water fowl, has been improved by planting vegetation from Frankfield Loch and other Glaswegian sites (pers. comm. Sheila Russell). These plantings may have contributed the reed beetles that have raised the site's score. The second highest site is one of the few areas of seepage encountered, in this case the outflow of a balancing lagoon of the M77 at St. Martin's. The site with the greatest number of species, a pool behind the Phoenix Industrial Estate near to Glasgow Airport, scored third highest. This pool would appear to man-made in that it is formed by subsidence. Even the lowest scoring site, a peat ditch on Lenzie Moss, has

one species of interest, *Hydroporus tristis*, but this and the other species present are characteristic of acid water that is still common around Glasgow.

## DISCUSSION

There are many species of water beetle in and around Glasgow, their habitat range is diverse, and some species are in decline if not locally extinct whilst others are increasing. Declining species are associated mainly with peat, with running water and with exposed lake shores.

Pond species are generally doing well and do not require further conservation activity except that pond creation generates public interest and stewardship. The instant gratification of building a new pond cannot be denied! However, conservation activists are urged to avoid damage to existing temporary marsh systems in this process as many beetles require both vegetation cover and the periodic drought to eliminate predatory fish. Moving vegetation locally to soften the hard edge of a typical park pond has proved effective at Bingham's Pond, introducing host plants for showy beetles and providing marginal refugia for others.

Peatlands still exist in quantity around Glasgow despite the industrialisation and urbanisation of the area. The species dependent on a peat substratum will be the next to disappear unless the loss of peat is halted, preferably by flooding - so there is still scope for large scale pond creation. Land developments such as out-of-town shopping malls and golf courses, and the tidying up of brownfield sites just for the sake of tidying up could cause more damage than the industries from which the city grew.

## ACKNOWLEDGEMENTS

Thanks firstly go to Richard Weddle for having invited me to attend the Urban Biodiversity Conference in sufficient time to permit a survey to be done. Along with Elizabeth Illingworth, of the Friends of Lenzie Moss, Eilidh Spence, of Glasgow Living Water, and several members of the ranger services for Glasgow City Council and North Lanarkshire Council, Richard proved most helpful in alerting me to sites and their access. Of the rangers I would like to single out Lindsay Gemmell for escorting me around Pollok Country Park. My friend Steven Routledge also accompanied me on part of the survey as did Geoff Hancock, who should also be acknowledged for providing access to the collections of the Hunterian Museum, University of Glasgow. The Balfour Beatty team is thanked, in particular Dave Allen for facilitating access to the lagoons along the new trunk road system and to Grant Kennedy for escorting me and Geoff to some of the ponds. It will not have escaped the attention of some that the 2010 survey conducted by the author did not yield a species new for Scotland, whereas Craig Macadam's survey did! Thanks go to Craig for the chance to examine his beetle material.

	Last record	No. 10 km squares	Quality score
Suborder Adephaga			
GYRINIDAE			
<i>Gyrinus aeratus</i> Stephens	2008	1	5
<i>Gyrinus caspius</i> Ménétriés	1913	2	4
<i>Gyrinus marinus</i> Gyllenhal	1915	3	4
<i>Gyrinus minutus</i> Fab.	1976	3	4
<i>Gyrinus substriatus</i> Stephens	2010	13	2
<i>Orectochilus villosus</i> (Müller)	1987	3	4
HALIPLIDAE			
<i>Brychius elevatus</i> (Panzer)	1910	3	4
<i>Haliphus confinis</i> Stephens	2010	7	3
<i>Haliphus flavicollis</i> Sturm	2010	7	3
<i>Haliphus fluviatilis</i> Aubé	1983	6	3
<i>Haliphus fulvus</i> (Fab.)	2010	11	2
<i>Haliphus immaculatus</i> Gerhardt	2010	6	3
<i>Haliphus lineatocollis</i> (Marshall)	2010	13	2
<i>Haliphus lineolatus</i> Mannerheim	2004	9	2
<i>Haliphus obliquus</i> (Fab.)	2010	1	5
<i>Haliphus ruficollis</i> (De Geer)	2010	14	2
<i>Haliphus sibiricus</i> Motschulsky	2010	14	2
NOTERIDAE			
<i>Noterus clavicornis</i> (De Geer)	2010	6	3
DYTISCIDAE			
<i>Agabus affinis</i> (Paykull)	2010	7	3
<i>Agabus arcticus</i> (Paykull)	1976	6	3
<i>Agabus biguttatus</i> (Olivier)	1932	5	3
<i>Agabus bipustulatus</i> (L.)	2010	19	1
<i>Agabus congener</i> (Thunberg)	2010	6	3
<i>Agabus guttatus</i> (Paykull)	1989	8	2
<i>Agabus labiatus</i> (Brahm)	1910	3	4
<i>Agabus nebulosus</i> (Forster)	2010	7	3
<i>Agabus paludosus</i> (Fab.)	2010	8	2
<i>Agabus sturnii</i> (Gyllenhal)	2010	15	2
<i>Agabus unguicularis</i> (Thomson)	2010	6	3
<i>Ilybius aenescens</i> Thomson	1974	2	4
<i>Ilybius ater</i> (De Geer)	2010	9	2
<i>Ilybius fuliginosus</i> (Fab.)	2010	15	2
<i>Ilybius guttiger</i> (Gyllenhal)	2010	5	3
<i>Ilybius montanus</i> (Stephens)	2010	6	3
<i>Platanibus maculatus</i> (L.)	2008	9	2
<i>Colymbetes fuscus</i> (L.)	2010	13	2
<i>Rhantus exsoletus</i> (Forster)	2010	12	2
<i>Rhantus frontalis</i> (Marshall)	2010	2	4
<i>Rhantus suturalis</i> (Macleay)	2010	2	4
<i>Rhantus suturellus</i> (Harris)	1976	4	3
<i>Acilius canaliculatus</i> (Nicolai)	1992	5	3
<i>Acilius sulcatus</i> (L.)	2010	6	3
<i>Dytiscus marginalis</i> L.	2010	10	2
<i>Dytiscus semisulcatus</i> Müller	2000	8	2
<i>Graptodytes pictus</i> (Fab.)	1980	3	4
<i>Hydroporus angustatus</i> Sturm	2010	11	2
<i>Hydroporus discretus</i> Fairmaire	2010	7	3
<i>Hydroporus erythrocephalus</i> (L.)	2010	12	2
<i>Hydroporus ferrugineus</i> Stephens	1957	4	3
<i>Hydroporus gyllenhalii</i> Schiödt	2010	18	1
<i>Hydroporus incognitus</i> Sharp	2010	13	2
<i>Hydroporus longicornis</i> Sharp	1990	4	3
<i>Hydroporus melanarius</i> Sturm	1998	5	3
<i>Hydroporus memnonius</i> Nicolai	2010	13	2
<i>Hydroporus morio</i> Aubé	1989	7	3
<i>Hydroporus nigrita</i> (Fab.)	2010	12	2

<i>Hydroporus obscurus</i> Sturm	2010	6	3
<i>Hydroporus obsoletus</i> Aubé	1968	1	5
<i>Hydroporus palustris</i> (L.)	2010	17	1
<i>Hydroporus planus</i> (Fab.)	2010	13	2
<i>Hydroporus pubescens</i> (Gyllenhal)	2010	19	1
<i>Hydroporus rufifrons</i> (Müller)	1853	1	5
<i>Hydroporus striola</i> (Gyllenhal)	2010	13	2
<i>Hydroporus tessellatus</i> Drapiez	2000	1	5
<i>Hydroporus tristis</i> (Paykull)	2010	11	2
<i>Hydroporus umbrosus</i> (Gyllenhal)	2010	12	2
<i>Nebrioporus assimilis</i> (Paykull)	2004	11	2
<i>Nebrioporus elegans</i> (Panzer)	2004	12	2
<i>Oreodytes davisii</i> (Curtis)	1974	4	3
<i>Oreodytes sanmarkii</i> (Sahlberg)	2008	9	2
<i>Oreodytes septentrionalis</i> (Gyllenhal)	1987	9	2
<i>Stictonectes lepidus</i> (Olivier)	1910	2	4
<i>Stictotarsus duodecimpustulatus</i> (Fab.)	1984	10	2
<i>Hygrotus confluens</i> (Fab.)	1999	4	3
<i>Hygrotus impressopunctatus</i> (Schaller)	2010	4	3
<i>Hygrotus inaequalis</i> (Fab.)	2010	14	2
<i>Hygrotus nigrolineatus</i> (von Steven)	2010	1	5
<i>Hygrotus novemlineatus</i> (Stephens)	1911	2	4
<i>Hyphydrus ovatus</i> (L.)	2010	6	3
<i>Laccophilus minutus</i> (L.)	2010	5	3
Suborder Polyphaga			
HELOPHORIDAE			
<i>Helophorus aequalis</i> Thomson	2010	13	2
<i>Helophorus arvernicus</i> Mulsant	2008	4	3
<i>Helophorus brevipalpis</i> Bedel	2010	16	1
<i>Helophorus flavipes</i> Fab.	2010	13	2
<i>Helophorus grandis</i> Illiger	2010	11	2
<i>Helophorus granularis</i> (L.)	2010	3	4
<i>Helophorus griseus</i> Herbst	2010	1	5
<i>Helophorus minutus</i> Fab.	2010	9	2
<i>Helophorus obscurus</i> Mulsant	2010	8	2
<i>Helophorus tuberculatus</i> Gyllenhal	1915	1	5
HYDROCHIDAE			
<i>Hydrochus brevis</i> (Herbst)	1853	1	5
HYDROPHILIDAE			
Hydrophilinae			
<i>Anacaena globulus</i> (Paykull)	2010	19	1
<i>Anacaena lutescens</i> (Stephens)	2010	7	3
<i>Chaetarthria seminulum</i> s. lat.	1987	2	4
<i>Enochrus coarctatus</i> (Gredler)	2010	2	4
<i>Hydrobius fuscipes</i> (L.)	2010	15	2
<i>Laccobius bipunctatus</i> (Fab.)	2010	13	2
<i>Laccobius colon</i> (Stephens)	2010	3	4
<i>Laccobius minutus</i> (L.)	2010	4	3
<i>Laccobius striatulus</i> (Fab.)	1983	2	4
Sphaeridiinae			
<i>Coelostoma orbiculare</i> (Fab.)	1989	5	3
<i>Cercyon marinus</i> Thomson	2010	3	4
<i>Cercyon ustulatus</i> (Preyssler)	1985	1	5
HYDRAENIDAE			
<i>Hydraena britteni</i> Joy	2000	3	4
<i>Hydraena gracilis</i> Germar	2008	2	4
<i>Hydraena nigrita</i> Germar	1983	1	5
<i>Hydraena riparia</i> Kugelann	2010	13	2
<i>Limnebius nitidus</i> (Marsham)	1919	1	5
<i>Limnebius truncatellus</i> (Thunberg)	2010	14	2
<i>Enicocerus exsculptus</i> (Germar)	1987	3	4
<i>Ochthebius dilatatus</i> Stephens	2010	2	4

<i>Ochthebius minimus</i> (Fab.)	2010	2	4
SCIRTIDAE			
<i>Microcara testacea</i> (L.)	1999	1	5
<i>Cyphon hilaris</i> Nyholm	1999	1	5
<i>Cyphon padi</i> (L.)	2000	1	5
<i>Cyphon variabilis</i> (Thunberg)	2010	4	3
ELMIDAE			
<i>Elmis aenea</i> (Müller)	2008	5	3
<i>Esolus parallelepipedus</i> (Müller)	1987	2	4
<i>Limnius volckmari</i> (Panzer)	1990	5	3
<i>Oulimnius tuberculatus</i> (Müller)	1987	4	3
<i>Riolus cupreus</i> (Müller)	1987	2	4
<i>Riolus subviolaceus</i> (Müller)	2008	1	5
HETEROCERIDAE			
<i>Heterocerus marginatus</i> (Fab.)	1853	1	5
COCCINELLIDAE			
<i>Coccidula rufa</i> (Herbst)	2010	2	4
CHRYSOMELIDAE			
<i>Plateumaris discolor</i> (Panzer)	2010	4	3
<i>Plateumaris sericea</i> (L.)	2010	2	4
<i>Donacia obscura</i> Gyllenhal	1979	1	5
<i>Donacia simplex</i> Fab.	2010	1	5
<i>Donacia versicolore</i> (Brahm).	1992	2	4
<i>Donacia vulgaris</i> Zschach	2010	2	4
<i>Macrolea appendiculata</i> (Panzer)	1967	1	5
<i>Galerucella nymphaeae</i> (L.)	2010	4	3
<i>Hydrothassa marginella</i> (L.)	2010	2	4
<i>Phaedon armoraciae</i> (L.)	2010	2	4
<i>Phaedon cochleariae</i> (Fab.)	2010	1	5
<i>Prasocuris phellandrii</i> (L.)	2010	5	3
CURCULIONIDAE			
<i>Phytobius lencogaster</i> (Marshall)	1994	2	4
<i>Bagous alismatis</i> (Marshall)	1900	2	4
ERIRHINIDAE			
<i>Erirhinus aethiops</i> (Fab.)	2008	2	4
<i>Notaris acridulus</i> (L.)	1901	4	3
<i>Grypus equiseti</i> (Fab.)	1901	1	5

**Table 1.** Water beetles recorded in and around Glasgow.

National grid reference	Site	VC	Date	No. spp.	AQS	MQS	Noteworthy spp.
NS55436811	Bingham's Pond	99	5 June	15	42	2.8	<i>Haliphys confinis</i> , <i>Donacia simple</i> , <i>D. vulgaris</i>
NS50495149	M77 Mearns box	76	12 May	5	13	2.6	<i>Hydrothassa marginella</i>
NS45286466	Phoenix Industrial Estate	76	24 April	24	61	2.5	<i>Phaedon cochleariae</i>
NS64857181	Lenzie Moss 2	99	10 April	10	24	2.4	<i>Agabus congener</i>
NS6720672	Gartloch Pool	77	5 June	17	40	2.4	<i>Haliphys confinis</i> , <i>Cercyon marinus</i>
NS707684	Gartcosh 4	77	20 March	15	35	2.3	<i>Acilius sulcatus</i> , <i>Agabus unguicularis</i>
NS651673	Cardowan 1	77	27 March	19	43	2.3	<i>Rhantus suturalis</i>
NS70576838	Gartcosh 6	77	5 April	15	34	2.3	<i>Haliphys confinis</i> , <i>H. obliquus</i>
NS4566160	Durrockstock pond	76	1 May	6	14	2.3	
NS654674	Cardowan 2	77	27 March	16	35	2.2	<i>Rhantus frontalis</i> , <i>Helophorus granularis</i>
NS55336220	Pollok Country Park, marsh	77	4 May	5	11	2.2	
NS62806838	Robroyston Park 2	77	17 July	17	38	2.2	<i>Phaedon armoraciae</i>
NS62776805	Robroyston Park 1	77	10 April	15	32	2.1	
NS50495147	M77 Mearns box	76	12 May	19	40	2.1	<i>Ilybius guttiger</i> , <i>Phaedon armoraciae</i>
NS707684	Gartcosh 3	77	20 March	12	24	2.0	<i>Hydroporus tristis</i>
NS653674	Cardowan 3	77	27 March	8	16	2.0	
NS52775930	Darnley Mill	76	1 May	12	24	2.0	
NS60576568	Cathkin Marsh 2	77	1 May	6	12	2.0	
NS60325791	Cathkin Marsh 3	77	1 May	16	32	2.0	
NS707685	Gartcosh 5	77	20 March	17	33	1.9	<i>Enochrus coarctatus</i>
NS43926568	Linwood Moss 2	76	24 April	14	27	1.9	<i>Ilybius guttiger</i>
NS51725274	M77 Mearns box	76	12 May	17	33	1.9	
NS705682	Gartcosh 1	77	20 March	13	24	1.8	
NS706687	Gartcosh 2	77	20 March	8	14	1.8	<i>Ochthebius dilatatus</i>
NS52195380	M77 Junction 5	76	12 May	14	25	1.8	
NS54795411	Titwood	76	12 May	12	21	1.8	
NS603722	Wilderness Plantation 1	99	5 April	3	5	1.7	
NS63466936	Robroyston Road	77	10 April	11	19	1.7	
NS55336220	Pollok Country Park, The Glade	77	4 May	3	5	1.7	
NS52225375	M77 Junction 5	76	12 May	11	19	1.7	
NS54565429	Titwood	76	12 May	7	12	1.7	
NS43656600	Linwood Moss 1	76	24 April	16	26	1.6	
NS55336220	Pollok Country Park, main pond	77	4 May	7	11	1.6	
NS601721	Wilderness Plantation 3	99	5 April	5	8	1.6	
NS60576568	Cathkin Marsh 1	77	1 May	4	6	1.5	
NS602721	Wilderness Plantation 2	99	5 April	2	3	1.5	
NS64787171	Lenzie Moss 1	99	10 April	6	8	1.3	<i>Hydroporus tristis</i>

**Table 2.** Summary of the 2010 survey. The vice-counties (vc) are 76 Renfrewshire, 77 Lanarkshire, and 99 Dunbartonshire. AQS is the aggregate quality score, i.e. the sum of all the species quality scores. MQS is the mean quality score, the average quality score value per species.

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## Urban Biodiversity: Successes and Challenges: Clydebank as a hotspot for the common pill woodlouse *Armadillidium vulgare*

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### ABSTRACT

In Scotland, the common pill woodlouse is at the Northern edge of its range. On the east coast it extends as far north as Johnshaven. Until a recent discovery in Helensburgh, the northernmost location in the west was Clydebank, where two sites were discovered by Futter (1998). An additional four sites have since been discovered, which is an unusual degree of clustering. Five of the six Clydebank sites are alongside railways. Consideration is given to factors permitting the species to arrive, survive and thrive in railway-side sites, and in Clydebank.

### THE COMMON PILL WOODLOUSE IN SCOTLAND

The common pill woodlouse *Armadillidium vulgare* is the most widespread of seven native British species in the family Armadillidae, hence the addition of "common" to its traditional vernacular name. It is one of the most common of all woodlouse species in southern Britain, but in Scotland it is more sparsely distributed and at the edge of its range. The nature of its Scottish distribution has become more clear as recording coverage has improved. The first published atlas of woodlice in Britain and Ireland (Harding & Sutton, 1985) showed three groupings of records: on the east coast as far north as Tayside; on the Solway coast; and inland among horticultural nursery sites in the Clyde valley between Rutherglen and Lesmahagow (Harding, Collis & Collis, 1980). There was just one west coast record, from Troon Station by J. Naden in 1976.

By the time data were compiled for a new atlas (Gregory, 2009), increased recording effort had resulted in a good number of additional records, including some published in *The Glasgow Naturalist* (Stirling, 1995; Futter, 1998) and records from a field meeting of the British Myriapod

and Isopod Group in Ayrshire in 2006 (Collis, 2007), plus a number of additional records by the author.

Comparison of the two atlases makes it clear that the difference in numbers of records between the east and west coasts in Harding and Sutton's atlas was partly an artefact of recording effort. However, the tendency for the species to extend further north in the east than in the west seems likely to be real, with a 2005 record from as far north as Johnshaven in the east (Davidson, 2010). In the west, the northernmost locations shown in the 2009 atlas were Futter's (1998) two sites in Clydebank, though in May 2009 the author found a site a little further north in Helensburgh, NS303820, at the shore end of a footpath from East Clyde Street.

Gregory's 2009 atlas also confirms that, in Scotland, the distribution of the pill woodlouse is predominantly coastal. Many of the coastal sites are on, or very close to the shoreline, which might be considered it's primary natural habitat in most of Scotland. However, care is needed in this respect. The record from Johnshaven was among builders rubble deposited above a shingle beach (Davidson, 2010). The Helensburgh shoreline site could equally well be regarded as a suburban site with a high potential for the introduction of small invertebrates among rubble, garden waste, etc., dumped on the shoreline. There is a strikingly similar suburban shoreline site at Boathouse Road, Largs, NS197607. A site at Fairlie, NS207541 could also be classified as suburban shoreline, but with the further complication of a nearby wholly artificial coastline constructed in the 1970s for the Hunterston deep-water ore and coal terminal. A railway line followed the artificial coastline to service a now-dismantled iron ore reduction plant. Much of the material for the construction project was obtained locally, from Biggles Quarry and Campbeltown Farm (<http://www.hunterston.eu/oreterminal>), but doubtless other materials were brought in from further afield.

**CLYDEBANK SITES**

The first records of the pill woodlouse in Clydebank were by Futter (1988). In the period 1995-1997, she located specimens in a suburban garden in Parkhall Road, NS488718, and around a disused band hall on Second Avenue, NS495710. I visited these two locations in June 2007 and found the species in large numbers (>100) around the band hall and also beside the church close-by on Second Avenue. On Parkhall Road, instead of searching gardens, I found the species in small numbers in public shrubbery areas at NS489718 - close to Futter's location.

Two features of the band hall site are that it is immediately adjacent to a railway line and, like much of Clydebank, it is on a south facing slope. The pill woodlouse is believed to favour sunny locations; unusually for woodlice it is sometimes found in full sunlight (Gregory, 2009). The band hall is in a very sunny location, elevated above the railway line on the other side of which the land falls away sharply to the south. Having found pill woodlice associated with railways in England and Wales, and mindful of Cawley's

(1996) observations in Ireland, as and when opportunities arose I searched railway-side sites elsewhere in Clydebank. Non-railway habitats were not searched so thoroughly.



**Fig. 1.** Sketch map of Clydebank sites for the common pill woodlouse: 1 Parkhall Road, NS488718; 2 Second Avenue (derelict band hall) NS495710; 3 Argyle Road railway bridge, NS501705; 4 John Knox Street NS504694; 5 Cable Depot Road (abandoned docks line) NS490705; 6 Clydebank Public Park/Dalmuir Station NS484714.

In May 2008 I found the species among rubbish at the base of railings separating railway land from mown grass at the north-east corner of Argyle Road railway bridge, NS501705. Like the band hall site, this is on the Singer line. Subsequently, I discovered a site on the Yoker line (NS504694, November 2009), among rubble at the base of a brick wall separating railway land from the site of a demolished building, accessible from John Knox Street.

The Yoker and Singer lines converge at Dalmuir Station. Here too I found pill woodlice among rubble at the base of the railway-side fence where it is accessible from the southern corner of Clydebank Public Park (NS484714, June 2010). In the park, I also found it a short distance away from the railway, where the Park borders the western end of Regent Street (NS484715). I was unable to find this species in a search of the glasshouses and their immediate surroundings at the western-most corner of the Park (NS480716), even though glasshouses and horticultural areas are often favoured by the species. It's absence there cannot easily be explained by an overuse of pesticides since I easily found the woodlice *Oniscis asellus*, *Philoscia muscorum*, *Porcellio scaber*, *Porcellio spinicornis* and *Trichoniscus pusillus* agg. at this location. Of course, pill woodlice may yet be found there.

In addition to the Singer and Yoker branches of the railway network through Clydebank, there are also the remains of branch lines to the docks. I found pill woodlice at the foot of the embankment of one such disused line (NS490705, June 2010), accessed from an abandoned industrial site on Cable Depot Road.

Conservatively, if we consider the two closely adjacent sites in Clydebank Public Park (Dalmuir Station and end of Regent Street) as one, and similarly with the two Parkhall Road sites (suburban garden and public shrubbery), there are now six known sites for pill woodlice in Clydebank (Fig. 1). This is a remarkable cluster of sites within a small area.

There is a similar density of known sites in the Salisbury Crags/Holyrood Park/Duddingston area of Edinburgh. Not very far from this cluster, on 16/08/2010 I was able to locate three new sites along a short stretch of railway line: at the pedestrian underpass in the University sports ground at Peffermill, (NT280712); on the cycle path beside the railway at Bingham (NT297721); and by the road bridge over the railway at the south-west corner of Jewel Park (NT304721). I am also aware of two railway-side sites in Edinburgh located by the late Bob Saville in May 1994, at (NT219724) and (NT226718).

For reasons of more ready access from my home in Bute, I have spent far more time on a greater number of different dates searching the Gourock-Greenock-Port Glasgow area, including many railway-side sites, and have not yet found any pill woodlice. It is probably significant that with the ground rising steeply to the south, this area is much less sunny than south-facing Clydebank. It is also possible to make comparisons with central Glasgow where I spent much time looking for woodlice in the 1970s (Collis & Collis, 1978) though I did not examine many railway-side sites. I did not find any pill woodlice though I was brought specimens from a now abandoned nursery at Westfield Avenue, Rutherglen, (NS605612).

## DISCUSSION

How might the Clydebank cluster of sites be explained? To understand the distribution of a species that is not ubiquitous in an area, we need to consider how it might arrive at new sites, what conditions are needed in order for the arrivals to breed sufficiently well for the colony to survive, and why the colony is able to thrive so as to become numerous enough that it will persist through occasional severe conditions.

For medium-sized flightless invertebrates like pill woodlice, arrival presumably requires it to be carried to a new site, conceivably in flood debris or driftwood, but more likely by inadvertent human transport. In the latter case, there will be a bias toward them arriving in habitats associated with human activity. It is well understood that many species of woodlice are particularly likely to be found in synanthropic sites, but it is not straightforward to disentangle the relative contributions of anthropic factors for arrival and for survival.

One strong possibility for how they might arrive at locations throughout greater Glasgow and Clyde area is through the movement of agricultural and horticultural produce. Prior to the dominance of motorised transport, the movement of fodder and bedding for horses is likely to have been a significant factor in the transport of invertebrates in urban areas. Several species of woodlice, including *Armadillidium vulgare*, are known to flourish in horticultural nurseries. They are still present at two sites in Rothesay where there were once extensive commercial glasshouses (Collis & Collis, 2008), and the species is known from various sites with horticultural connections, including the nursery in Rutherglen, mentioned above, several nursery sites in the Clyde valley (Harding, Collis & Collis, 1980), Culzean Castle gardens and the 'gardens' area of the agricultural college site at Auchincruive (Collis, 2007).

It is well understood that 'hothouse' alien woodlice (Gregory, 2009) are transported with plant material between botanic gardens, and there can be little doubt that this also applies to commonplace plants used in domestic gardens and allotments. Maybe the Parkhall Road colony of pill woodlice became established in this way. It was once common for allotments to be established beside railways, but it is not clear whether this applies to any of the railway side pill woodlouse sites in Clydebank. There is also the potential for transport in garden waste discarded onto areas that are regarded as "waste ground". Garden waste can include rubble from paths and rockeries, etc., as well as plant material and soil. It is often seen dumped on railway land, although this was not particularly noticeable at the Clydebank sites. As noted in the introduction, garden waste is also dumped on suburban shorelines, and on rural shorelines too, especially near roadside lay-bys.

There is also a strong probability that woodlice, including *A. vulgare*, are transported in various construction materials including quarried stone and aggregates, especially if the material had some calcareous content, or topsoil (Cawley, 1996). Other possibilities are timber, bricks, concrete fabrications, pipes, and general steelwork, especially if such items have been stored in the open for long enough for them to have become colonised by woodlice. Railway track is normally bedded on hard rock chips, which are typically non-calcareous, but I have information that it is not unusual for the foundations to be formed from softer calcareous rock. Depending on the source location, it is easy to envisage lime-loving invertebrates such as pill woodlice being introduced in such material. In addition to the basic bed of the track, a wide variety of materials are involved with railway-associated structures.

Irrespective of how woodlice got to the railway-side sites, we still need to understand why they have survived and thrived, especially, it seems, in railway-side sites in Clydebank. Even if there is no calcareous rock in the foundation of the trackway, there is likely to be an ample supply of lime in mortared walls and various line-side structures. Pill woodlice are much less tolerant of wet conditions than other woodlice, and the open well-

drained substrate would suit them well, with relatively large interstices allowing this bulky species easy movement through spaces to find microsites that are suitable in a variety of climatic conditions. Clydebank has the added advantage of a sunny south-facing aspect.

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Urban Biodiversity: Successes and Challenges: Urban tern ecology: common terns in Leith Docks

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The Imperial Dock Lock, a disused lock wall in Leith Docks, Edinburgh, supports the largest common tern (*Sterna hirundo*) colony in Scotland and was designated

as a Special Protection Area (SPA) for the species in 2004. The SPA lies in a continually changing operational port and the port owners are keen to understand more about the terns. Analysis of long-term count data suggests that colonisation of this urban environment occurred as a result of relocation from natural islands in the Firth of Forth over the past few decades, in particular Inchmickery, which was formerly a regional stronghold for the species, but was abandoned possibly due to high numbers of gulls. Field work was performed at the colony during the breeding seasons of 2009 and 2010. Foraging studies showed that terns fed primarily in the Firth of Forth rather than within the docks, and their diet consisted mostly of clupeids, but also sandeels and small gadoids. Predation of chicks by herring gulls (*Larus argentatus*) and lesser black-backed gulls (*L. fuscus*) was observed in both seasons, despite which, high numbers of chicks fledged from the colony. Observations and preliminary experiments on the terns' sensitivity to disturbance at the colony indicated that the birds are tolerant of routine human activities in the docks and that they have become well habituated to breeding in this urban environment. The results of this study combined with continued monitoring will be useful for the conservation of this SPA.

Urban Biodiversity: Successes and Challenges: Human perceptions towards peri-urban deer in Central Scotland

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Red deer (*Cervus elaphus*) have been successfully breeding in the Scottish highlands for centuries, and many people have a classic association of herds of deer roaming over the vast expanding Scottish hills. However, today species such as roe deer (*Capreolus capreolus*) are increasingly being seen in and around Scotland's Central Belt, producing a very different human perception of deer than in the Scottish Highlands. Roe deer bring benefits and impacts to peri-urban areas (communities consisting of urban and rural components) within the Central Belt. It is not yet known peoples' perception towards deer in more urbanised communities, and whether they perceive deer to be beneficial to the local environment or a hindrance.

In the UK there is an estimated 316,000 red deer, 300,000 roe deer, 128,000 fallow (*Dama dama*), 128,000 muntjac (*Muntiacus reevesi*) and 26,600 sika (*Cervus nippon*) and 2100 Chinese water deer (*Hydropotes*

*inermis*) (Mammal Society, 2012). Deer abundance for all red, roe, fallow, sika and muntjac deer species has been recorded in the Scottish Highlands for 10 consecutive years, (2000-2010) indicating deer densities to be as high as 30 per km<sup>2</sup> in the Perthshire area, just north of Pitlochry and in the north west area of Drumnadrochit (SNH, 2012). Furthermore the lowest deer density of 1-5 deer per km<sup>2</sup> stretches from Inveruglas in central Scotland to Cape Wrath in the north and from the Outer Hebrides to the west side of Banchory (SNH, 2012). Red deer were recorded throughout the Scottish Highlands, though not recorded in the Central Belt and regions to the South East of Scotland. (NBN, 2012). Roe deer are more widely distributed than red and are found throughout the whole of Scotland, except from the Shetland islands and the Outer Hebrides. (NBN, 2012). Sika deer are more widely distributed than fallow deer in Scotland, but less so than red or roe, found widely distributed in the North West Highlands of Scotland and in Central Southern Scotland (NBN, 2012). Fallow deer were recorded in over 110 10 km<sup>2</sup> in Scotland with a much more sparse distribution compared with red and roe deer with pockets of higher densities in the west and east central Highlands, and in South West Scotland. (NBN, 2012). Muntjac deer were noted in 15 10 km<sup>2</sup> regions in Scotland sparsely distributed throughout Scotland (NBN, 2012). Deer abundance in these peri-urban communities is also not well known. In order to address some of these questions Forest Research on behalf of the Deer Commission for Scotland was asked to undertake a social and ecological study to: A) Examine if deer presence was being felt in peri-urban communities by members of local communities in Central Scotland and to highlight the benefits of possible deer presence, B) Undertake an ecological study on deer density within Central Scotland ascertaining whether deer density figures tied in with peoples' experience of deer presence in their local community.

To complete both studies two case study areas were set up; Ravensaraig in the West of Central Scotland and Linlithgow in the East of Central Scotland. The two areas were chosen for their mosaic of urban and rural areas and were seen as classic peri-urban environments.

For study A, 7 focus groups were conducted in total between each case study area (6 in Ravensaraig and 1 in Linlithgow) to examine what people in the local community thought about deer in their local area, and 3 manager focus groups were conducted (2 in Ravensaraig and 1 in Linlithgow) to examine what professional deer managers thought about deer in Central Scotland. 'Deer manager' in this case refers to people who have a higher level of knowledge about deer management than the general public, and relates to professional deer stalkers, forestry officials and members of conservation groups. At each focus group a series of slides were shown to participants, and a general introduction to each slide was talked about before the group engaged with the subject. Managers and community focus group structures were identical. To further facilitate study A, a questionnaire

was sent out to local community groups ranging from allotment groups, to local sports associations. The questionnaire like the focus groups asked about local deer presence in their area and asked participants to rate deer management options in response to hypothetical deer management situations. In total 415 questionnaires were sent out and 154 were returned, giving the study a successful response rate of 37%.

For study B, night time thermal imaging of deer occurred along farm road transects in each case study area using a Pilkington Lite imager. See Dandy *et al.* (2009) for full survey methods. When deer were seen through the camera, the number of deer, the co-ordinates of their position and distance from the car guestimated, and noted down. The results were then placed in a statistical programme to generate density figures.

For the social study A the participants did show that deer were in their area agreeing with the general perception that deer are using peri-urban environments:

"It's made my day when I've seen them. .... It makes all the difference...Fantastic difference..." (Community Group 1)

"...it's nice to know that they are around. It just makes people feel more natural, a more natural environment." (Community Group 7)

The general feeling from the community focus groups was that deer did exist in the community but that they were not very prevalent, perhaps this relates to the roe deer's timid nature and being mainly active very early in the morning when most people are still asleep. In no way did any community focus group think that deer were overabundant in their community.

Study A also highlighted the benefits that deer bring to their community:

"If you catch sight of the deer, it means the environment is on a high because they're in the area. And if you're not getting good ecology and good feeding grounds they just move away, you see less and less of them.. it's letting you know that the environment and the ecology in the area is really good" (Community Group 6)

As well as bringing in a human wellbeing factor, deer in the local community were seen as a sign that the environment they were living in was healthy. Therefore deer presence was an indicator of living in a healthy green community which many residents see as a positive benefit to where they live. From the questionnaire participants were asked to rank statements in accordance to their preference to the question: 'If the number of deer in the area where you lived increased, which of the following would be the most important priorities?' Participants produced the following order of statements starting with the highest priority:

1. Preventing road-traffic accidents involving deer
2. Ensuring the welfare of individual deer
3. Maintaining the cultural value of deer in Scotland
4. (Joint) Preventing deer damaging local woodlands
4. (Joint) Preventing deer damaging gardens and other vulnerable sites
6. Making a living from deer through deer-watching tourism
7. Obtaining economic income from deer through sport shooting 'stalking'

From the ranking exercise the first statement indicated that if the local deer population was to increase, preventing direct physical road traffic accidents with deer would be the highest priority. This statement being first shows that the community would like to prevent the risk of a serious accident with deer as it is the only statement which contains a serious risk to humans of having deer in the local community. No other statements perceive such a high risk to humans in particular. It could be seen that the first statement protects humans and deer from risk. In the second statement, 'ensuring the welfare of individual deer' it shows that people in general have a high regard for deer welfare in their area, and would like to prevent harm being inflicted on local deer populations. The second statement's position correlates with the general findings from the focus groups that people enjoy seeing deer and therefore want to care for them in some way by looking after their welfare. Direct damage by deer seen in the two statements in joint 4<sup>th</sup> position shows that direct physical impacts by deer were not of a high concern for residents. Least concern was the statement relating to obtaining economic gain from a local deer population via sport shooting. This correlates with results from the focus groups that sport shooting was mainly only done in the Scottish Highlands and wouldn't be an activity by people in Central Scotland. A comment from the focus group was:

"I couldn't see them [tourists] coming here and saying 'while we are in Motherwell and Lanarkshire, we'll go and see deer'. But I would think they might think that way if they were heading for the Glencoe area for instance or above Stirling..." (Community Group 1)

Therefore it is perceived that no economic value would be practically obtained by local people if deer were sport hunted in their local community.

From study B it was found that deer in Linlithgow had a deer density estimate of 0.9/km<sup>2</sup> in open areas and 0.8/km<sup>2</sup> in forested areas. Ravenscraig had a deer density estimate of 3.3/km<sup>2</sup> in forested areas and 1.4/km<sup>2</sup> in open areas. These density estimates are rough estimates as not all transects could be done due to access issues in 2009, but the vast majority were completed. Furthermore the estimates were taken from driving along farm roads at night and it can be assumed that not every deer can be seen from farm road positions. Roe deer were distinguished from other deer by their small to mid size and by the fact that they were seen in groups of about 2 or 3 individuals. The thermal imaging camera only showed a bright silhouette of deer so it was reliant on the

observer to fully determine if the deer seen was roe. However local knowledge and experience of using the thermal imaging camera before helped to reduce identification bias. The results however show that deer densities are relatively low for both case study areas and show that Ravenscraig has a higher deer density than Linlithgow, and could be due to the Ravenscraig site having a higher sampling intensity with 188 km<sup>2</sup> sampled compared to 88 km<sup>2</sup> in Linlithgow. (This was in part due to snowfall preventing more sampling being undertaken in Linlithgow at time of survey). Overall the densities for each case study are in agreement with focus group findings that deer exist in the community but are not very commonly seen by residents.

The study shows through thermal imaging surveys, questionnaires and via focus groups that roe deer are penetrating into peri-urban environments within Central Scotland and this is the first study of its kind in Scotland. The density of deer is low in comparison to mean deer densities in the Scottish highlands that may be as great as 30/km<sup>2</sup> (SNH, 2012), but the landscape and deer species (red deer) being different are contributing factors for this difference. The study also highlights the respect the general public have for deer, and the benefit deer have to the wellbeing of humans within peri-urban environments, as with most nature species. In relation to the theme of connecting communities and nature discussed at the Glasgow Natural History Society Conference on Urban Biodiversity, there were several plans to develop green corridors in urban environments to improve connectivity of nature. Such ideas were the Integrated Habitat Networks proposed by SNH, Woodlands In And Around Towns by the Forestry Commission, Living Waters project by Froglife and the importance of bings and brownfield sites were highlighted by the University of Edinburgh and Buglife respectively. These schemes would encourage deer and other species to move into and around urban and peri-urban environments. This may help to increase peoples' perceptions that they are living in a healthy environment because their local area is supporting species such as roe deer. Increasing deer populations in peri-urban environments may raise important management issues. If deer numbers were to increase substantially impacts such as deer vehicle collisions and damage to parks and gardens will need to be addressed. However from the focus groups and questionnaire no management was deemed necessary by residents as the deer population was seen as too low to justify any current management plans. Therefore deer in peri-urban environments at this moment in time present a positive factor if seen in local green spaces.

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## Urban Biodiversity: Successes and Challenges: Epigeal invertebrate abundance and diversity on Yorkshire allotments

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### ALLOTMENTS: FASCINATING HABITATS

After more than half a century of neglect and decline, allotments are on the brink of a great revival (Foley, 2004). Recent decades in particular have witnessed a growing demand for allotments, partly linked to the demand for healthy, pesticide-free food and an escape from the pressures of modern, busy urban lives. The image of traditional plot-holders e.g. retired men may be slowly changing. Allotment plots are increasingly managed by young women and professional couples keen to grow organic crops or seek an escape from the daily grind (Buckingham, 2005; pers obs). In parallel to the increased interest in the socio-economic, health and recreational benefits of allotments, there is a growing interest in the biodiversity value of these unique mosaics of intensively managed habitat (Gilbert, 1991). However, to date there has been little published research which concentrates on them.

Marshall (2009) used a questionnaire-based survey to assess garden and allotment biodiversity and attitudes to it. He found that, among other things, having direct contact with plants and wild animals in a garden or allotment helped foster a wider interest in nature. Thus, allotments, because they typically involve a cross-section of a community, can offer an ideal opportunity to engage people on an individual or community level and allow them to take a greater interest in their local wildlife.

The aims of our research were to test any variation in epigeal (ground-dwelling) invertebrate abundance and diversity along an urban-rural gradient, in relation to any effects of allotment plot management styles i.e. traditional or wildlife-friendly.

### GENERAL APPROACH

A questionnaire-based survey was used to determine plot-holder attitudes to allotment management styles and the importance of wildlife on the sites. From these data, individual plots across allotment sites in east Yorkshire were identified to sample the epigeal invertebrates. In addition, plots were assigned as being either 'traditional' or 'wildlife-friendly' based on self-declaration. A range of environmental data were collected to determine the urban-rural gradient e.g. rural sites were likely to have a high percentage of surrounding farmland whilst urban sites were likely to have a high percentage of surrounding hard cover. These data were informed by the results of the Biodiversity in Urban Gardens in Sheffield (BUGS) project which examined, among other things, garden invertebrate biodiversity (Smith *et al.*, 2006 a,b). Three pitfall traps, pooled per plot, were used to sample invertebrate abundance and diversity in May and September 2006 on six plots from each of seven sampling sites chosen ( $N = 6 \times 7 \times 2 = 84$  plots compromised/vandalized = 74). These sites represented an urban-rural gradient and each site contained three 'traditionally' managed plots and three organic, wildlife-friendly plots, as identified from the questionnaires.

### BIOLOGICAL DATA

Pitfall trapping resulted in the collection of 11,718 individual organisms; eight taxa were subject to further analysis. There was a significant difference in the mean number of individuals per allotment site (Fig 1). The rural Driffild allotment site contained significantly lower overall invertebrate abundance compared to the Newland site in Hull city centre, which had the highest abundance. Although none of the other sites were statistically different from each other, there was a trend towards an increase in mean abundance moving towards the city centre.

Beetles (Coleoptera) constituted 37.95%, woodlice (Isopoda) 24.03% and spiders (Araneae), 16.93% of the catch respectively. Urban sites tended to be dominated by woodlice whilst beetles tended to be more common on some suburban and rural sites. The results for spiders and the other five taxa, whose abundance ranged between 0.73% - 8.96% of the total catch, showed mixed abundance across the urban-rural gradient (Fig 2).

With regard to overall invertebrate abundance in relation to management styles, the urban wildlife-friendly managed plots contained significantly higher abundance compared to all other plots, except the urban traditional plots. The latter, whilst not statistically significant, did not contain such high abundance as the urban wildlife plots. This therefore highlighted a trend towards increased abundance along the rural, suburban, urban gradient, especially on those plots managed in a wildlife-friendly way.

The effects of management style on individual taxa gave mixed results; different taxa dominated over differing management styles. Beetles were significantly more abundant on traditionally managed plots. In contrast, the woodlice, slugs and snails (Mollusca) were significantly more abundant on wildlife-friendly managed plots. Spiders, opilione, millipedes and centipedes (Myriapoda) showed little difference in abundance in relation to management style. The most biologically diverse plots were managed in a wildlife-friendly way, with the highest diversity found on a rural site at Driffeld. Interestingly, this site also contained the lowest diversity on the traditionally managed plots.

**DISCUSSION**

This study has shown that there is considerable interest from allotment plot-holders in projects that recognize the value of “their” allotments. Whilst older men still dominate, there are an increasing number of community groups, younger families and especially women, taking on allotments. The latter are also more likely to place a higher value on the wildlife on their plots and sites, as shown by their commitment to manage their plots in an organic, wildlife-friendly way.

The epigeal invertebrate taxa on the seven allotment sites studied showed a significant variation in both abundance and diversity along an urban-rural gradient. In contrast to what may have been expected, the urban sites contained the highest abundance whilst the rural sites contained the lowest. Whilst urban sites are likely to be subject to a higher range of anthropogenic pressures, each allotment site may be a small-scale biodiversity oasis, due partly to the lack of other suitable surrounding habitat patches compared to rural areas.

The composition of the taxa found in the current study was similar to that of the BUGS studies mentioned above, but the actual proportions of some of the taxa were quite different. For example, Smith *et al.* (2006) found that the three most abundant taxa of the pitfall traps were woodlice (45%), beetles (25%) and slugs (19%) respectively, whilst in the current study they constituted 24%, 38% and 9% respectively. The most abundant taxa, the beetles, dominated the rural, and to lesser extent suburban, sites. The woodlice, however, dominated the urban sites, suggesting that they prefer synanthropic environments. In addition, spiders contributed 17% of the total catch, compared to less than 5% in the BUGS study.

The reasons for these differences are likely to be many

and require further exploration. However, in the case of the slugs, it is likely that this group would be very actively discouraged from allotments, due to their primary *raison d'être* as a means of growing food crops. Slug pellets were the most common pesticide used, as evidenced in the questionnaires, supporting this conclusion.

Whilst management style suggests no *overall* difference in total invertebrate abundance, the differences at geographic scale do appear to show some effect. The higher abundance found on the wildlife-friendly allotment plots in the city centre may be due to a skewed effect of the high number of woodlice on these plots, as discussed above.

Overall, the diversity of the taxa found suggests that allotments are valuable habitats for epigeal invertebrates. The highest invertebrate diversity, found at the rural Driffeld wildlife-friendly plots, corresponds with their low abundance and requires further study to try and explain the reasons. The environmental data gathered suggests that the high proportion of farmland surrounding the allotment site may account for some of the variation. Species are likely to be able to disperse readily into the surrounding habitat, unlike the more constrained urban habitat patches.

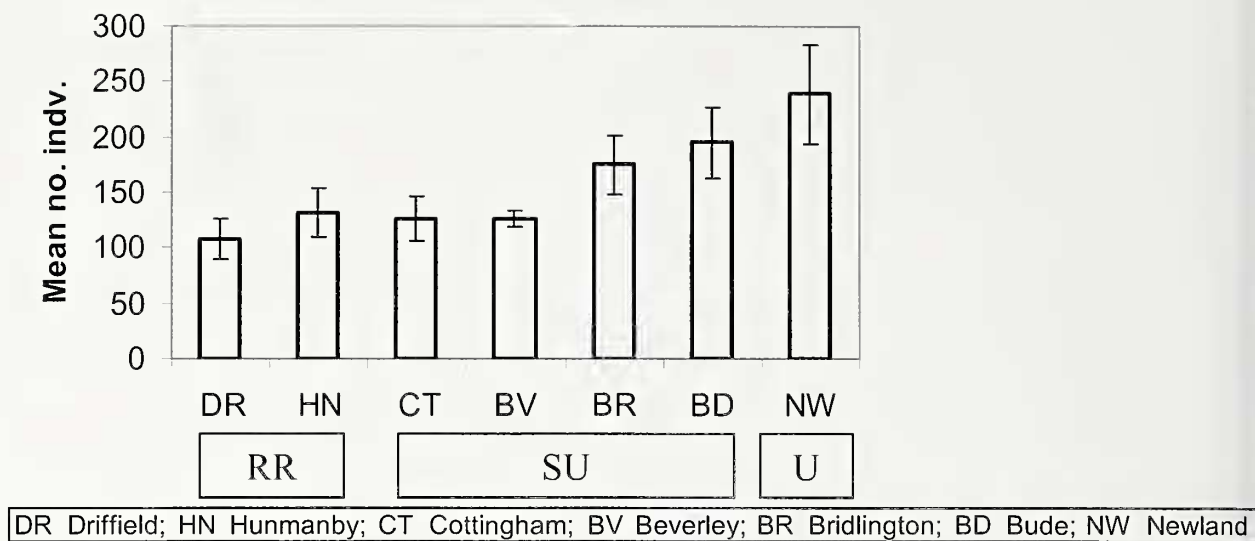
**FUTURE WORK**

Further work is ongoing to identify the three most abundant taxa to species level from a rural, suburban and urban allotment site respectively. Additional analysis of the questionnaire data, environmental and biological data will be published separately in due course. This work will therefore provide some much-needed empirical data on the epigeal invertebrate communities present on Yorkshire allotments. This baseline information could then be used to explore further issues such as biological control methods or effects of climate change on crop growing on allotments.

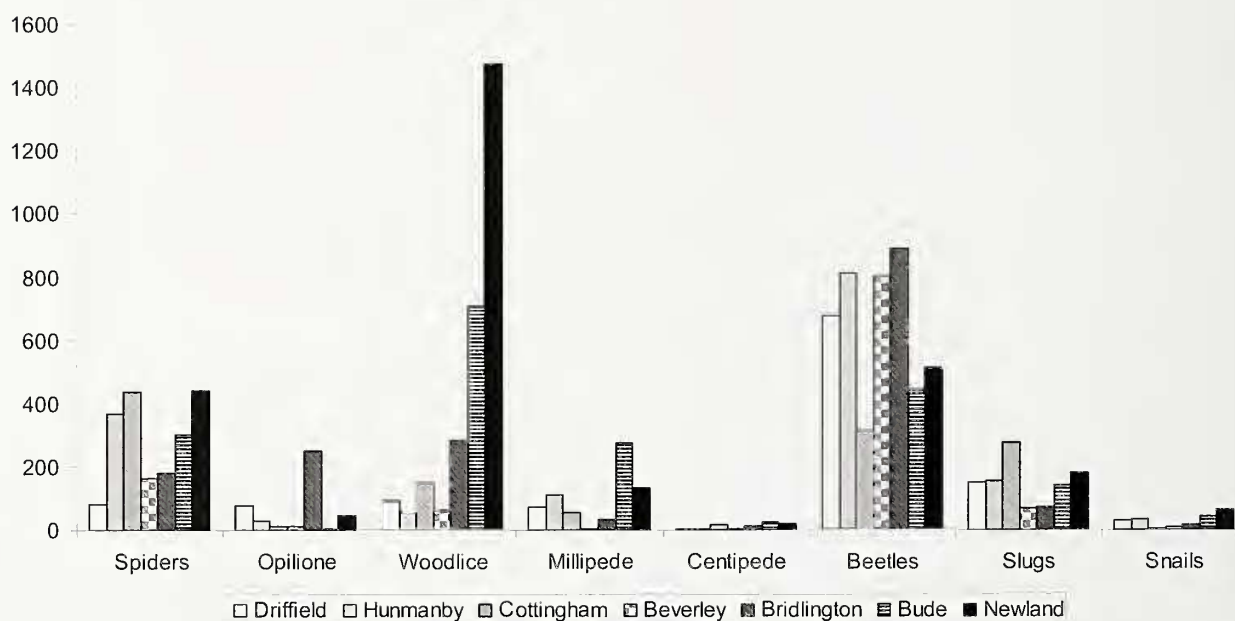
**CONCLUSIONS**

The increase in popularity of allotments offers a great opportunity to study the wildlife benefits of such sites, particularly in urban areas where greenspace is at a premium. In order to advance these studies, it is important to engage with individual plot-holders.

The epigeal invertebrate taxa found on these allotments are similar to those found in garden studies, but the proportions of dominating taxa vary across the urban-rural gradient and with management styles. Abundance was higher on urban plots, especially wildlife-friendly managed ones, compared to both traditionally and wildlife-friendly managed plots on rural or suburban sites. Invertebrate diversity was highest on some wildlife-friendly rural plots, which also had low abundance. Future work will help identify the specific species present and provide further clues to their ecological role on allotment sites.



**Fig. 1.** Mean number of invertebrates per Yorkshire allotment site ( $\pm$  SE), based on individual plot totals (N=74), grouped per urban-rural gradient. (RR=rural; SU=suburban; UU=urban.)



**Fig. 2.** Total number of each invertebrate taxon from pitfall-traps on seven Yorkshire allotment sites.

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Urban Biodiversity: Successes and Challenges: Brownfields: oases of urban biodiversity

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ABSTRACT

Despite their potential to support biodiversity, a strong negative public image has been attached to brownfield sites, with the conservation of these sites therefore lagging behind other habitats. The inclusion of ‘Open Mosaic Habitats on Previously Developed Land (OMHPDL)’ as a UK Biodiversity Action Plan (UKBAP) priority habitat has however resulted in a renewed focus on brownfields as important wildlife habitats. The experiences of Buglife – The Invertebrate Conservation Trust in both the Thames Gateway and central Scotland have shown that brownfield sites can support many rare, scarce and UKBAP priority species, some of which are becoming increasingly reliant on such sites as their natural habitats come under threat.

INTRODUCTION

The industrial revolution starting in the eighteenth century transformed the scenery of our towns and countryside. Central Scotland was at the heart of this revolution and many heavy engineering works and iron foundries were based there. With the demise of these industries across the country, their former premises have been left derelict. Many of these ex-industrial

sites have since been reclaimed by nature through natural succession.

This rich industrial heritage of Scotland has resulted in over 10,000 hectares of land being listed as vacant or derelict. These brownfield sites can be incredibly important for biodiversity, often supporting nationally important populations of rare and endangered invertebrates, alongside other wildlife such as birds, reptiles, plants and lichens. With the loss of natural habitats in the wider countryside through agricultural intensification and development, wild areas within the urban environment have become crucial to the survival of many increasingly threatened species in the UK. As a result Open Mosaic Habitat on Previously Developed Land (OMHPDL) was recently included as a UKBAP priority habitat.

Brownfields are any site that have been altered by human activity and are currently not fully in use (CABE, 2006). They tend to be concentrated in urban and former industrial landscapes but also include quarries, spoil heaps, old railway lines and disused airfields (Allan et al. 1997; Bodsworth et al. 2005; Whitehouse, 2008; Riding et al. 2010). Brownfield sites provide linkages or ‘stepping stones’ between more natural areas of habitat and facilitate the movement and mixing of individuals in a less favourable urban setting. Lack of management of brownfields often creates an open mosaic of habitats such as species rich grassland, bare ground and early successional habitats (Key, 2000; Bodsworth et al. 2005; Harvey et al. 2008). This, combined with a low nutrient content of the soil which prevents fast growing species becoming dominant, provides a continuity of resources for invertebrates throughout the season (Harvey et al. 2008). In addition, a mosaic of habitats provides a home for a wide range of species and allows many to complete their life cycles within the same site (Bodsworth et al. 2005).

It has long been recognised that brownfields may have as many associated Red Data Book (RDB) and Nationally Scarce invertebrate species as ancient woodlands (Jones, 2003). At least 194 invertebrate species of conservation importance, including 50 red data book and 131 nationally scarce species, have been recorded from brownfield sites in the UK. This includes 50% of rare solitary bees and wasps and 35% of rare ground beetles (Bodsworth et al. 2005). Brownfields also support a suite of UKBAP priority species. For example, the lack of management on brownfield sites often provides a secure area for breeding birds such as skylark (*Alauda arvensis*) and grey partridge (*Perdix perdix*), that are often absent from land under agricultural management. Many features identified at long abandoned industrial sites can no longer be found in the managed and over-farmed wider countryside or even in over-tidied parks (Bodsworth et al. 2005). Loss of natural habitat is causing many species, including bumblebees, beetles, butterflies and reptiles, to become increasingly reliant

on brownfield sites.

Despite their potential to support biodiversity a strong negative public image has been attached to brownfields due to lack of management and a perceived untidiness and they are increasingly threatened by development and landscaping (Key, 2000; Riding et al. 2010). Restoration of post-industrial sites into greenspace can destroy much of the existing wildlife interest through the importation of large quantities of topsoil and tree planting. Site restoration can also result in the loss of particular niches at brownfields which will have a knock on effect on the wildlife found at that site (Bodsworth et al. 2005). For example, the loss of bare ground at a site will affect thermophilic (warmth-loving) invertebrate species such as spiders and ground beetles as well as species such as mining bees and solitary wasps that nest in the ground (Key, 2000; English Nature, 2005; Whitehouse, 2008).

In 2007 Open Mosaic Habitat on Previously Developed Land was added to the list of priority habitats in the UK Biodiversity Action Plan (Maddock, 2008). To fit the UKBAP criteria for OMHPDL the site must be over 0.25 hectares in size and have a known history of disturbance (Table 1). In addition, there must also be a mosaic of vegetation on the site comprised of early successional communities and un-vegetated bare areas.

Criteria
1. The area of open mosaic habitat is at least 0.25 ha in size.
2. Known history of disturbance at the site or evidence that soil has been removed or severely modified by previous use(s) of the site. Extraneous materials/substrates such as industrial spoil may have been added.
3. The site contains some vegetation. This will comprise early successional communities consisting mainly of stress tolerant species (e.g. indicative of low nutrient status or drought). Early successional communities are composed of a) annuals or b) mosses/liverworts or c) lichens or d) ruderals or e) inundation species or f) open grassland or g) flower rich grassland or h) heathland.
4. The site contains un-vegetated, loose bare substrate and pools may be present.
5. The site shows spatial variation, forming a mosaic of one or more of the early successional communities a) – h) above (criterion 3) plus bare substrate, within 0.25 ha.

**Table 1.** Open mosaic habitat on previously developed land definition and criteria (Riding et al. 2010).

The conservation of brownfield sites has lagged behind other important habitats for plants and wildlife. The term brownfield was first used by the government in 1998 when they set a national target of 60 % of all new housing developments to be located on brownfield land (Bodsworth et al. 2005; Riding et al. 2010). In

Scotland, the National Planning Framework aims to bring ‘vacant and derelict land’ back into productive use for housing, for economic purposes and to create attractive environments however there is potential for this vision to conflict with the conservation of Open Mosaic Habitats on Previously Developed Land OMHPDL and urban biodiversity.

**BROWNFIELDS AND BUGLIFE**

Buglife was one of the first conservation organisations to highlight the ongoing loss of brownfield habitats – and the serious consequences of this for biodiversity – and has been working to conserve brownfield wildlife since 2004. Buglife’s flagship ‘All of a Buzz in the Thames Gateway’ project in southern England has mapped and assessed the biodiversity of over 1,000 brownfield sites. This study has identified that although as many as a third of all brownfield sites support high levels of biodiversity – in many cases significantly higher than surrounding ‘greenfield’ agricultural land – many of these sites are being lost to development as a result of government targets for new housing.

Brownfield sites in the Thames Gateway are very important for the brown-banded carder bee (*Bombus humilis*) and the shrill carder bee (*Bombus sylvarum*). The East Thames corridor with its large areas of open flower rich brownfield grasslands is home to the most important remaining metapopulations of these bumblebees.

The streaked bombardier beetle (*Brachinus sclopeta*) was thought to be extinct in Britain but was rediscovered in 2005 on a brownfield site in London (Jones, 2006). The site is currently being developed for housing and as mitigation around 65 beetles have been translocated to a nearby site. Invertebrate translocations typically have a low success rate, particularly with species with complex life histories as is the case with the streaked bombardier. It is therefore highly unlikely that this mitigation will save this species at this site and it may well become permanently extinct in Britain.

The distinguished jumping spider (*Sitticus distinguendus*) was discovered during surveys in 2005 at West Thurrock Marshes (Harvey, et al., 2005). This species is only known from one other site – Swancombe Marshes where it is threatened by re-development proposals. The site at West Thurrock currently has planning permission for warehousing and car parking which, if developed, would destroy the habitat of this species.

**THE SCOTTISH EXPERIENCE**

Evidence suggests that this issue is as pressing in Scotland as elsewhere. In September 2010 Buglife launched a new project ‘All of a Buzz Scotland’ as a response to this challenge. This project follows in the successful footsteps of work completed in the Thames Gateway. The first phase of this project assessed 1,522 sites listed as ‘derelict’ on the Scottish Vacant and

Derelict Land Register and identified 393 sites that had the potential to satisfy the UKBAP criteria for OMHPDL. The assessment of these sites followed a remote assessment methodology using aerial photography to identify features typical of OMHPDL (Macadam, 2011).

It was noted during this initial assessment that some of the aerial photography was up to 12 years old and the sites identified as potentially fitting the criteria for OMHPDL may no longer qualify as a priority site due to re-development or succession during the intervening period. The next phase of this project is therefore to ground-truth the results from the initial assessment to ensure that we can have confidence in the findings. Advice and information on how to assess a site for the presence of OMHPDL to ensure that Local/Planning Authorities and Government Agencies can identify areas of OMHPDL on 'new' sites in the future will also be prepared. Future phases of the project will promote the management of brownfield sites for biodiversity and provide guidance on tools for mitigation in developments such as green and living roofs, and off-site habitat creation.

The 'All of a Buzz in Scotland' project will produce much-needed evidence and support for planners and developers, enabling them to plan and implement developments in an environmentally sustainable way. It will also promote more natural habitats, native plant species, and a 'less tidy' approach to land management both within developments and in the wider urban landscape.

**FALKIRK'S BROWNFIELDS**

Buglife has recently undertaken a more detailed investigation of the invertebrate diversity of brownfield sites in the Falkirk area (Bairner and Macadam, 2011). An assessment of the habitat on each of the 76 sites in the Scottish Vacant and Derelict Land Register for Falkirk was undertaken during May 2010. Details of each site were recorded using Buglife's brownfield habitat assessment form and included current activity, the vegetation type, plant species diversity and abundance. Photographs were taken on each site for future reference. Potential invertebrate species diversity was estimated as low, medium or high for each site based on plant abundance and plant species diversity on the site as well as the presence of a mosaic of habitats, including bare ground, scrub and mixed grassland and herbs.

From the sites on the register, 19 were chosen as being important for invertebrates.

Invertebrate survey work was undertaken on 14 of these sites. The remaining sites from the register fitting the OMHPDL criteria were visited for assessment purposes but no invertebrate survey work was possible due to access restrictions. In addition invertebrate surveys were also undertaken at two other sites which are not on the vacant and derelict land register, but have been previously recognised as fitting the criteria for OMHPDL.

Surveys of brownfield sites in Falkirk commenced in May 2010, with the majority of field work carried out between June to October 2010 and March to June 2011. Samples of terrestrial invertebrates were collected using pitfall traps, sweep nets and/or pan traps. When collected each sample was labelled with site name, collection method and date and stored in 70% alcohol. Samples were first sorted into different invertebrate orders and then identified to family, genus or species by close examination under a high power microscope with reference to taxonomic books and keys. Most groups were identified to species, however in the Diptera, Myriapoda, Acari, Collembola and Mollusca a lower taxonomic precision was used in some cases.

Of the invertebrate species collected during survey work 75 have not been recorded from the Falkirk area before. A number of these species are common and widespread in Britain including the green tiger beetle (*Cicindela campestris*) and violet ground beetle (*Carabus violaceus*), the field digger wasp (*Mellinus arvensis*) and marram spider (*Tibellus maritimus*). Results show that 44 of the 72 species of beetle recorded during survey work have not been recorded in Falkirk before. The reason why there are no records for many species, particularly beetles, may be due to the lack of a local biological records centre for the area, although there are relatively few active entomologists in the area.

The diversity of invertebrate species collected clearly shows the importance of brownfields in Falkirk. As an example, the brownfield at Carron Works (Forge Dam) is particularly important due to the high diversity of plants and wildlife, especially the invertebrates that were recorded. Four invertebrate species collected at this site are considered rare or scarce in Scotland:

- The comb-footed spider *Anelosimus vittatus* (Theridiidae) is widespread and common in England and Wales although there are only a few records in Scotland.
- The hobo spider *Tegenaria agrestis* (Agelenidae) is a brownfield specialist and was previously only known from five locations in Scotland (Bo'ness, Grangemouth, two locations in Edinburgh and near Dingwall in the Highlands).
- The Nationally Scarce (Notable B) ground beetle *Amara praetermissa* (Carabidae) was recorded in Bo'ness in the 1980s and during field work three individuals were collected from Carron Works. This represents only the second record of this species in Scotland.
- The rare (RDB3) solitary bee *Andrena ruficrus* (Andreninae) has previously not been recorded from Falkirk.

**CONCLUSIONS**

Open mosaic habitats with varying stages of natural succession are scarce in the over-managed and farmed countryside. In an urban setting brownfields can be used as 'stepping stones' to allow movement and

mixing of animals and plants across an area (Macadam, 2011). Due to natural succession at these sites, brownfields are transitory habitats and if left unmanaged they have a typical lifespan of between 15 and 20 years (Key, 2000; Bodsworth et al. 2005). This is not necessarily a problem as new 'brownfield' sites are always being created. The transitory nature of these sites means that the extent of this habitat will fluctuate as a result of succession, redevelopment and dereliction. The species that inhabit these sites will colonise and retreat in response to the availability of the habitat in each local authority area however it is important that a series of 'stepping stones' are provided as refugia for these species. These 'stepping stone' sites should be managed to retain an open mosaic of habitats for the species that depend upon them.

If properly managed, brownfield sites with high value for biodiversity can not only deliver suitable habitat for many species, but can also transform themselves into wild city spaces full of wildflowers that will attract pollinators and other animals. Such sites are an important part of the habitat network, providing corridors for species to disperse around and through urban areas. Brownfield sites can also provide valuable open spaces for local people and are often seen as being the only truly 'wild' city spaces remaining for the public to enjoy – the 'unofficial countryside'. There is great potential to make many of these sites more accessible, safe and enjoyable through imaginative planning and positive management. In many built-up areas, brownfield sites may be the sole natural greenspace available. If properly managed, they could help significantly to reduce the number of areas deficient in accessible open space, and contribute to the delivery of urban green networks. Improving access to green spaces will bring attendant quality of life and health benefits to residents, as well as economic benefits.

Recommendations made by Bodsworth et al. (2005) for the management of brownfield sites to maximise their value for invertebrate conservation include surveying sites to identify their wildlife interest and the protection of sites from development. Researchers also recommend the management of bare ground, vegetation structure, floristic diversity and shelter to maintain biodiversity at a site once its value has been identified.

The importance of brownfield wildlife in urban areas must be recognised and valued if it is to be protected and managed as a vital component of the townscape. Its long-term survival will depend on the support of the local people who use and value their local environment. Developing opportunities for people to see, enjoy and learn about brownfield invertebrates will help increase awareness and understanding of the value of biodiversity in urban areas.

## ACKNOWLEDGEMENTS

Buglife would like to thank Scottish Natural Heritage and the Central Scotland Green Network for funding the first phase of the 'All of a Buzz Scotland' project. We would also like to thank BTCV for the opportunity to host a Natural Talent apprentice.

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# Urban Biodiversity: Successes and Challenges: Integrated habitat networks in our dear green space.

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## ABSTRACT

The development of the spatial habitat networks known as Integrated Habitat Networks (IHN) was developed with a range of partners using GIS and suite of spatial analyst tools known as BEETLE. The first habitat networks were produced for the Glasgow and Clyde Valley area in 2008. A post was developed to disseminate the resultant woodland, grassland and wetland networks to local authorities and to assist them with the task of utilising these visual networks in development planning, development management and Master planning.

It has been used in a variety of trial projects working with architects, planners, SEPA and SNH and the use of IHN for production of green networks is slowly gaining momentum. A hypothetical use of IHN was illustrated within a presentation at the Glasgow Naturalist conference to visually demonstrate its use in land management and to illustrate the very visual use of the IHN.

## INTRODUCTION

In 2009 I started as project officer for the Glasgow and Clyde Valley Green Network Partnership (GCVGNP) and SNH. We are very lucky in Glasgow as the Glasgow and Clyde Valley Structure Plan promotes the vision of a Green Network and the newly emerging Strategic Development Plan carries this vision within its Main Issues Report (MIR). Our area could be considered pioneers of the green network concept as we are fortunate in having a GCVGNP team. In 2008 Forest Research were commissioned to produce habitat networks for the GCV area and to illustrate where these networks “integrated” thus producing Priority Enhancement Areas (PEA’s). This was undertaken using GIS and a suite of spatial analyst tools collectively given the name BEETLE (Biological and Environmental Evaluation Tools for Landscape Ecology).

The Planning etc. (Scotland) Act 2006 resulted in the previously non-statutory National Planning Framework (NPF) becoming a statutory document and this is effectively a spatial plan for Scotland. The Act also makes provision for the Framework to designate national developments. Within NPF2 (2009) The

Central Scotland Green Network (CSGN) is one of these national developments and the location and design of integrated habitat networks is clearly stated as one of the matters to be addressed in the creation of a CSGN. Additionally the national developments should be included within Strategic Development Plans (SDP) and Local Development Plans (LDP). The IHN has been used to assist within the planning process and small pilot projects have been undertaken in several areas now. To borrow from the Main Issues Report (MIR) for the Edinburgh and South East Scotland SDP (2010) known as SESPlan, the Green Network could be defined:

“[it] comprises the network of green spaces within and around our towns and cities, linking out into the wider countryside, which underpins the region’s quality of life and sense of place and provides the setting which high quality, sustainable economic growth occurs”

## SETTING THE SCENE

### *Spatial tool.*

The Integrated Habitat Networks allow us to spatially see where our efforts can be concentrated. We can see very visually see where the habitats cluster into networks and equally we can see where the habitats sit in isolation (Fig.1). Lastly the modelling process gives us an indication of the possible spread of species to surrounding habitat areas by using a process known as least cost distance analysis and this gives an indication of the networks that are possible in the future if there are to be no land use changes. These are the habitat networks illustrated by BEETLE.



**Fig. 1.** Example illustrating woodland habitat “clustering” and sitting in isolation  
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However the question of whether or not to target action to habitat clusters and also the sensitive subject of whether or not to concentrate efforts *only* on these larger areas capable of forming habitat networks will depend on a variety of factors outwith that of forming habitat networks alone. Priorities will vary on an area to area basis but will include factors such as socio-economics, sense of place and therefore local

importance as well as that of providing “stepping stones” for species. The list is not exhaustive.

#### Uses

To date SEPA and the GCVGN partnership has commissioned a Clyde pilot study “Ecological Networks and River Basin Management Plans (RBMP)” (Entec 2010) in order to align the RBMP objectives with an IHN for this area. Opportunities have been identified addressing diffuse pollution and reduction of morphological pressures on watercourses whilst also enhancing the IHN. It has also been used to aid the master planning process in Glasgow and South Johnstone and at development plan level was used in the Strategic Environmental Assessment for the South Lanarkshire Minerals Plan.

#### What does it actually do?

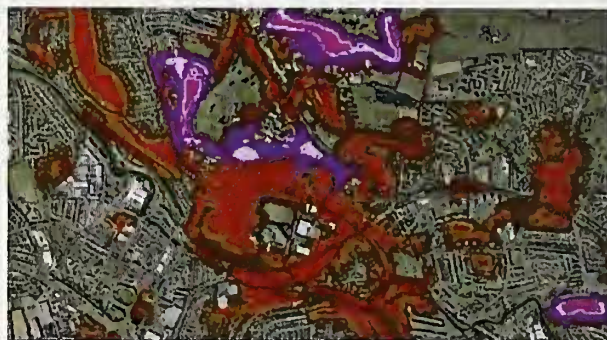
The IHN addresses habitat fragmentation by very visually illustrating the habitats that are in existence and the concentration is on wetland, woodlands and grasslands. Using a focal species approach to assess the functional connectivity of habitat for species distribution, a limited number of species were used to map the IHN's. This generalises the species requirements for a particular habitat and is widely used in habitat network modelling. It also removes the need to carry out a large number of individual species analyses (Smith 2008). Those used have included mountain hare *Mustela putorius*, great crested newt *Triturus cristatus*, red admiral *Vanessa atalanta*, dogs mercury *Mercurialis perennis* and water avens *Geum rivale* (Fig. 2). They encapsulate species requirements for particular habitats. Similar habitats in turn have been collated to form generalist habitats, woodland, wetland and grassland (Fig. 3) it is however possible to separate the network components to show specialised networks using GIS. Networks such as acid grassland and ancient woodland can be clearly illustrated for example and this ability to “drill down” may prioritise our land management decisions in the future.

The process of habitat network modelling has been taken a step further near Inverness as part of the planning process for Tornagrain to try to ensure that red squirrel strongholds are retained and expanded using the least cost distance analysis pioneered by Scottish Natural Heritage and Forest Research. Maps have been produced to illustrate the existing red squirrel areas and also the areas that could host red squirrels. All possible very quickly by computer modelling.

#### IHN MODELLING IN GLASGOW

The city of Glasgow is always depicted as the “dear green place”. The IHN generalist habitat layers allow us to see where our networks lie and see where there is habitat fragmentation. Phase 1 data, master map and a variety of other data sets have been used to calculate the networks. Note that the habitat networks are not

wildlife corridors. They are a component of the green network but the habitats within the IHN must fulfil certain criteria to be part of this so for example amenity grassland is generally not part of the habitat network. As mentioned previously it is even possible to further refine our visual display to show where our areas of ancient woodland are within the woodland generalist layer and additionally to use the modelling process to show how the network could expand (Fig. 4).



**Fig. 4.** Data licensed to Scottish Natural Heritage under the PGA, through Next Perspectives. Glasgow generalist woodland network (red), ancient woodland network (pink) and lilac and purple showing the possibility for expansion of the ancient woodland network.

To explain the IHN's possibilities it will be necessary to set the scene. Imagine that Glasgow has undergone a population explosion that necessitates the local authority to consider development of Dawsholm Park. I use this example because it is an instantly recognisable area on a map and it is an area valued for reasons other than that of being a valuable component of the IHN's! Fig. 4 shows that within the north west of Glasgow there is a substantial area of ancient woodland and also potential for ancient woodland expansion. However to look at the ancient woodland network for the whole of Glasgow (Fig 5) it is possible to see that these areas of ancient woodland are scarce throughout the city. Equally on a larger scale we can see at a glance where the habitat networks in Glasgow integrate and although the ecologists amongst us will be well aware of these “hotspots” it allows us to visually show the high habitat value of areas such as Possil Marsh SSSI which is an important component of the IHN. It does not sit in isolation (Fig. 5). Where the habitats networks integrate can be clearly seen as can areas that could be improved by appropriate land management can also be identified helping us to prioritise our habitat management.



Mountain hare *Lepus timidus*. © Lorne Gill



Red Admiral *Vanessa atalanta* © Lorne Gill.



Great crested newts *Triturus cristatus* © Sue Scott/SNH.



Dogs mercury *Mercurialis perennis*. © Lorne Gill/SNH



Water avens *Geum rivale* © Lorne Gill.

**Fig. 2.** Some of the focal species used for IHN analyses.



Woodland © Lorne Gill.



Wetland © Lorne Gill/SNH



Grassland habitat, Lorne Gill/SNH.

**Fig. 3.** Generalist habitats.

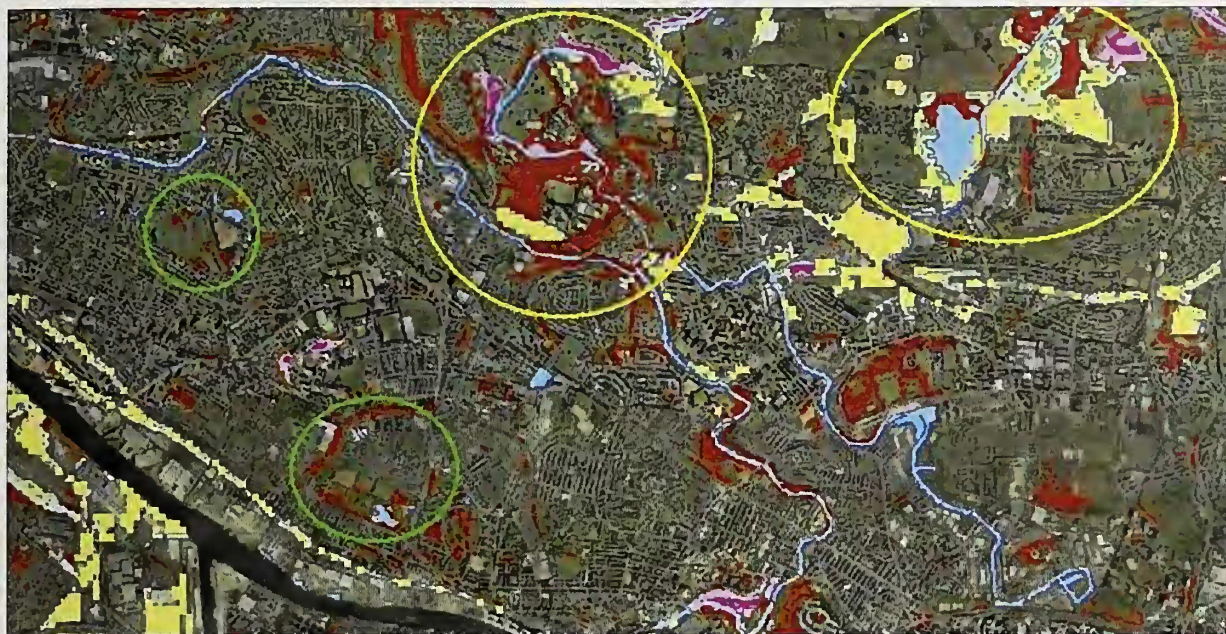


Fig. 5. Data licensed to Scottish Natural Heritage under the PGA, through Next Perspectives. Generalist woodland networks (red), ancient woodland (pink), grassland including marshlands (yellow and green) and wetland (blue).

## WEB BROWSER TOOL

Scottish Natural Heritage is presently working on a web browser tool to allow all of us with a land management interest to access the IHN layers to assist with our land management decisions. It will be possible to graphically see the effect of development, land use changes and also to assist land agent with their Scottish Rural Development Priority applications as there will be a web browser tool to allow us to add and for that matter remove land to see the effect on the habitat networks. The ecological network modelling will be possible throughout Scotland and access will be possible via the SNH website. [www.snh.org.uk](http://www.snh.org.uk).

## CONCLUSION

The IHN is a spatial tool which can assist us with our efforts to plan our green networks in only one area but also across our various local authorities. There will always be an element of ground truthing required but then the same can be said of any desk top analysis. Importantly we have the opportunity to strategically address habitat fragmentation and have a tool to assist us with the best possible "locations" for expansion of these networks.

## FOOTNOTE

Since the conference in October IHN's have been created for the whole of the Central Scotland Green Network area. Data and further information can be obtained from the Central Scotland Green Network Support Unit.

<http://www.centralscotlandgreennetwork.org>.

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## Urban Biodiversity: Successes and Challenges: The Biodiversity in Glasgow (BIG) project: the value of volunteer participation in promoting and conserving urban biodiversity.

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### INTRODUCTION

Glasgow is an ideal city in which to look at urban biodiversity. Over 20% of the area of Glasgow is green space including 74 parks, over 30 allotment spaces and other sites of potential importance to urban biodiversity such as rivers, woodlands, cemeteries and communal gardens. In terms of nationally recognised status of nature conservation, Glasgow holds 5 Sites of Special Scientific Interest (SSSIs) and 7 Local Nature Reserves (LNRs). It also has 46 and 49 Sites of Importance for Nature Conservation (SINCs) at the City and Local level respectively<sup>1</sup>. Glasgow City Council (GCC) in a strategic review of its green spaces identified a numbers of key actions including: (a) identifying amenity grass and road verges that could be subject to less intensive maintenance and; (b) the inclusion of biodiversity as an integral part of any development projects (GCC, 2005). GCC also has a programme of habitat enhancement including the naturalisation of artificial ponds and creation of further ponds and wetlands, wildflower meadows and native woodland. In addition the Glasgow Biodiversity Partnership has produced a Local Habitat Statement on "Built Up Areas and Gardens", as part of the Local Biodiversity Action Plan (LBAP) which highlighted the need to raise awareness of urban biodiversity through promoting access, encouraging public participation and the use of appropriate management practices<sup>2</sup>.

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<sup>1</sup><http://www.glasgow.gov.uk/en/AboutGlasgow/Factsheets/Glasgow/Environment.htm>.

<sup>2</sup><http://www.glasgow.gov.uk/NR/rdonlyres/5CF1528F-ABBC-4F8F-A3CC-AD6CFD8E98CB/0/LBDAPurban.pdf>

The importance of urban biodiversity has also been highlighted in the Scottish biodiversity strategy, a 25 year plan for the conservation and enhancement of biodiversity in Scotland. This document sets out five main objectives: halting the loss of biodiversity; increasing awareness of biodiversity and engaging people in conservation; restoring and enhancing biodiversity in urban, rural and marine environments; ensuring that biodiversity is taken into account in all decision making and; ensuring that existing knowledge on biodiversity is available to all policy makers and practitioners (Scottish Government, 2004). The Scottish Biodiversity Forum, in its implementation plans for 2005-2008, has also highlighted that urban green spaces are often poorly managed and sometimes dominated by non-native invasive species that are generally of low value for urban wildlife (Scottish Government, 2005). Consequently, urban environments such as green spaces and corridors offer huge potential for improvement through schemes to conserve and enhance biodiversity.

The Biodiversity in Glasgow (BIG) project was set up as a collaboration between the British Trust for Ornithology Scotland, Butterfly Conservation Scotland and Glasgow City Council and ran from January 2007 to April 2009. The main aim of the project was to carry out the largest ever volunteer survey of the birds, butterflies and their associated habitats within the green spaces of the city. This information was then used to determine which habitats are the most important in terms of enhancing bird and butterfly diversity within green spaces.

### METHODS

#### *Site allocation and training*

More than 100 green spaces were surveyed during the BIG project and full details are provided in Humphreys *et al.* (2011). The term green space, as used here covers a wide range of sites (eg. parks, cemeteries, allotments, urban woodlands, open spaces<sup>3</sup>) and in over 90% of cases were owned by GCC. Site allocation was based on proximity to either where volunteers lived or worked and wherever possible, were chosen by volunteers themselves. The size of green spaces used in the BIG project ranged from just under 2 ha to 168 ha (although the largest sites were subdivided for the purpose of surveying).

Although some of the BIG volunteers were highly experienced, many people had never carried out a survey before. Free training in species identification and survey techniques was therefore offered to all participants. A total of 108 and 88 people were trained for the bird and butterfly surveys respectively. Volunteers also received regular newsletters throughout the project which featured interim results,

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<sup>3</sup> The category of open space describes the various combination of a wide range of possible habitats which are not intensively managed including: wetland, raised bog, burns, woodlands, heathlands, pasture and open water.

personal accounts by participants and articles on the best green spaces in Glasgow to visit.

**Bird Surveys**

Volunteers were recommended to make a pre-survey visit in early April in order to estimate the percentage cover of the different habitats within their site. Three further visits were then made: mid April to mid May, mid May to mid June and mid June to mid July. Ideally survey visits were carried out between dawn and 09:00 but if that was not possible, observers were required to choose a time of day that was convenient and carry out future surveys at this fixed time. Volunteers were requested to walk a survey route in such a way that they covered the whole site to within 50m ensuring that they did not double count any birds eg. either by zigzagging or using parallel lines. Any bird species seen were then counted and allocated to the habitat type in which they were first seen. Species lists for all sites were checked over by GCC staff to identify records that were unlikely. In such instances, if these sightings could not be validated, they were subsequently removed from the site lists (see Humphreys *et. al* 2011).

**Butterfly and day-flying moth Surveys**

Volunteers were recommended to undertake a pre-survey visit in early May in order to set up their transect routes and estimate the percentage cover of the different habitats within their sites. Transects were designed to take less than 60 minutes, not exceed 2 km in length, and cover a fair representation of the habitats present at the site. A minimum of four monthly visits to carry out the transects were recommended: mid May-mid June, mid-June to mid July, mid-July to mid-August and mid-August to mid-September. Volunteers were requested to walk at a slow, steady pace counting all butterflies and any day-flying moths seen within 2.5m either side of the transect line and 5m ahead. Transects were to be carried out between 10:45 and 15:45 hours BST and ideally in good weather conditions (eg. minimum temp of 11°C and wind speeds less than 5 on the Beaufort scale). All records of butterflies were checked by BC Scotland volunteers who were able to flag up records which were questionable (based on location and time of year). In such instances unless validation was provided the record was deleted (see Humphreys *et. al* 2011).

**RESULTS**

**Birds**

A total of 91 species of bird was recorded in the city of Glasgow during the BIG project (with up to 61 species being recorded at one site alone). As expected, many birds were relatively abundant species, but what was surprising was the number with high conservation value. In total, there were 15 UKBAP and 4 LBAP birds species recorded along with 47 species of Birds of Conservation Concern (see Eaton *et al.*, 2009, for definition and Table 1). These key lists included species that have become synonymous with the urban environment such as House Sparrow, Swift and Starling, as well as species that are more commonly

associated with rural habitats including Tree Sparrow, Skylark and Yellowhammer.

Analyses were then carried out to look at the habitat associations of birds (see Humphreys *et al.*, 2011 for further details). Species richness was most influenced by the overall size: the larger the green space, the higher the species richness was likely to be. The presence of wild areas (unmown rank grass or wild/weedy areas) had the greatest single effect, with an average of 5.2 more species in green spaces where wild areas were present. The presence of a water body (natural or ornamental) was also found to be important. Green spaces with a water body had an average of 4.9 more species than those without. Furthermore, sites with a wetland/marsh area present had on average 2.8 more species than those sites without.

**Butterflies and day-flying moths**

Seventeen species of butterflies and 9 species of day-flying moths were recorded in the City of Glasgow by volunteers despite the relatively wet and cold conditions, particularly in 2008 when records were notably lower throughout the whole of the UK. Two species of butterfly had UKBAP listings: Small Heath and Grayling (Fox *et al.*, 2006). Exciting records included Comma, which was the first record for the city. The Comma is a generalist species that has a southerly distribution in Britain, although over the past few decades it has shown northern range expansions, almost certainly due to climate change (Warren *et al.*, 2001) and is therefore likely to become much more widespread in the future. Also of interest were the good numbers of Ringlets which indicate the rapid rate of colonisation of Glasgow by this particular species, which was first reported within the city boundary in 2005. There were conspicuously low numbers of the Common Blue, however, which is consistent with the documented widespread decline across the UK (Botham *et al.*, 2008).

Simple analyses were then carried out to compare the key habitat features of sites in which butterflies were recorded with those of sites having nil records (there were too few records for day-flying moths for any analyses to be meaningful). The mean percentage covers of wildflower/weedy areas for sites with and without butterflies were not significantly different. However, the mean percentage cover of unimproved or rank grass was significantly higher for those sites with butterflies compared with those without. This suggests that the area of unimproved grass could be an important determinant of whether butterflies will be present.

**RECOMMENDATIONS FOR GREEN SPACE MANAGEMENT**

**Birds**

The overall size of the green space was the most influential factor in determining species richness for birds. Larger sites by their very nature however are more likely to contain a greater number of habitats. Consequently it is difficult to tease apart the relative importance of size of green space in relation to greater

diversity of habitats (Chamberlain *et al.*, 2007). Although the size of existing sites cannot be easily augmented, there may be potential to increase area by landscaping adjacent land. Alternatively there could be opportunities to join up existing green space through the creation or enhancement of corridors, defined here as linear features with continuous wildlife habitat. Larger green spaces could be incorporated into the design of new towns.

Wild areas (e.g. patches of unmown rank grass and wild/weedy habitats) were also important. These particular habitats holding important numbers of invertebrates or being an important resource for seeds, particularly outside the breeding season. The presence of water bodies creates opportunities for an additional water bird community which could otherwise not be supported e.g. ducks and geese some of which have conservation listing (see Table 1). Wetland and marsh areas were also important for overall species richness and therefore, should accompany the creation of water bodies. Moreover for existing water bodies, there may be scope to incorporate wetland habitat if they do not already exist (e.g. naturalisation of water bodies).

### **Butterflies**

Unmown/ rank grass was shown to be an important factor in determining the presence of butterflies. Some sites, however, had unexpectedly poor numbers of butterflies despite having a high percentage. In such cases, the grassland was likely to be of amenity or agricultural origin and thus of little value to butterflies and moths as food resource (although it may provide overwintering habitat). In such instances the creation of new wildflower-rich or semi-natural grassland should be considered instead.

Consideration should also be given to the frequency of cutting regimes as nectar sources and caterpillars are destroyed by regular mowing. Even annual mowing of grasslands will cause losses to most butterflies and moths, except perhaps those that pupate in the soil. Thus if the site has to be mown, it is always better to have a variety of cutting regimes so a proportion of the population has a chance of survival.

## **CONCLUSIONS AND LESSONS FOR THE FUTURE**

The BIG project was extremely successful in encouraging new volunteers to go out and survey birds and butterflies. Volunteers had often previously felt that they lacked the skills or the confidence to get involved, so offering targeted training really was key to the success of the project. The first-time surveyors also reported taking great satisfaction in developing their identification skills as the project progressed, which really reinforces the message that the only way to truly learn is to get out there and practise!

There was also an issue of people's perception of green spaces particularly when volunteers were allocated a site that was previously unknown to them. A number of volunteers actually voiced their initial misgivings over

what were seemingly uninviting green spaces in the spring but by mid summer many of these sites had transformed. Participants also expressed their sheer joy at discovering birds and butterflies found at their site that would have been potentially overlooked by a casual visit.

By informing the management of urban greenspace and promoting the awareness of urban biodiversity, the BIG project made a significant contribution to the LBAP process. GCC has gone on to be involved with the Glasgow Living Water Project, a partnership with Froglife which has resulted in the creation of new ponds across the city and North Lanarkshire. Although the management of these water bodies is intended to benefit primarily amphibians, it is likely to enhance overall biodiversity. In addition, in 2011 the council started a new partnership project with Buglife called Glasgow's Buzzing which will create and enhance grasslands and meadows for the benefit of bees, butterflies and other key invertebrates. Although the BIG project was initially specific to Glasgow, any generic management advice will have applications for urban green spaces across Scotland and will therefore support the objectives of the Scottish Biodiversity Strategy. Therefore, if lessons from the BIG project are applied to other cities and towns, then we have demonstrated how anyone can help contribute to promoting and conserving biodiversity in Scotland.

## **ACKNOWLEDGEMENTS**

Firstly we would like to thank all the volunteers who participated in the BIG project. We would also like to thank Glasgow City Council who provided logistic support in terms of the distribution of promotional leaflets, free training venues and staff time in giving support and advice. Funding for the project was provided by Scottish Natural Heritage, Scottish Government, Glasgow City Council and the Robertson Trust.

Species	UKBAP	LBAP	BOCC
Pink-footed Goose			Amber List
Greylag Goose			Amber List
Gadwall			Amber List
Mallard			Amber List
Northern Pintail			Amber List
Common Pochard			Amber List
Tufted Duck			Amber List
Grey Partridge			Red List
Little Grebe			Amber List
Common Kestrel			Amber List
Eurasian Oystercatcher			Amber List
Ringed Plover			Amber List
Northern Lapwing	UKBAP		Red List
Eurasian Curlew	UKBAP		Amber List
Common Sandpiper			Amber List
Black-headed Gull			Amber List
Common Gull			Amber List
Lesser Black-backed Gull			Amber List
Herring Gull	UKBAP		Red List
Stock Dove			Amber List
Common Cuckoo	UKBAP		Red List
Common Swift		LBAP	Amber List
Kingfisher			Amber List
Skylark	UKBAP	LBAP	Red list
Meadow Pipit			Amber List
Grey Wagtail			Amber List
Sand Martin			Amber List
Barn Swallow			Amber List
House Martin			Amber List
Dunnock			Amber List
Whinchat			Amber List
Wheatear			Amber List
Song Thrush	UKBAP		Red list
Mistle Thrush			Amber List
Grasshopper Warbler			Red List
Whitethroat			Amber List
Wood Warbler			Red List
Willow Warbler			Amber List
Spotted Flycatcher	UKBAP		Red List
Starling	UKBAP		Red list
House Sparrow	UKBAP		Red List
Tree Sparrow	UKBAP	LBAP	Red List
Common Linnet	UKBAP		Red List
Lesser Redpoll	UKBAP		Red List
Bullfinch	UKBAP		Amber List
Yellowhammer	UKBAP		Red List
Reed Bunting	UKBAP	LBAP	Amber List

**Table 1.** Species of bird recorded in Glasgow as part of the BIG project which had a conservation listing. BOCC, Birds of Conservation Concern; LBAP, Local Biodiversity Action Plan; UKBAP, UK Biodiversity Action Plan.

Species	UKBAP	LBAP
Small Heath	UKBAP	
Grayling	UKBAP	

**Table 2.** Species of butterfly and moths recorded in Glasgow as part of the BIG project which had a conservation listing.

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Urban Biodiversity: Successes and Challenges: Bat activity in urban green space

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ABSTRACT

Green spaces within urban areas can be important for ameliorating the impacts of urbanisation on biodiversity, and can hold relatively rich wildlife communities. In contrast to some other taxa, relatively little is known about the ecology of bats in urban environments, and in this study we aimed to identify site-specific and wider landscape features that influence bat foraging activity within areas of urban green space. Bat activity primarily comprised *Pipistrellus pygmaeus* and was detected at 86% of parks surveyed. The presence of water bodies and woodland in urban parks increased bat foraging activity by a factor of 3.2 and 1.7 respectively. Data presented in this study indicate that, for this species, habitat within a site may be more important than the level of urbanisation or woodland cover in the surrounding landscape.

INTRODUCTION

*Urbanisation and green space*  
Urbanisation by expanding human populations reduces native biological diversity by decreasing the amount and quality of habitat available for wildlife, and by the fragmentation of remaining habitats (e.g. Marzluff *et al.*, 1998). It has been estimated that currently 50% of the world's population live in areas classed as urban, a figure set to increase along with the human population (United Nations, 2008). Urban development will therefore continue to grow, resulting in further losses of natural and semi-natural habitats, and increasing pressure on remaining habitat fragments which may suffer increasing isolation and deterioration in quality

(Marzluff and Ewing, 2001; Chamberlain *et al.*, 2007). Green spaces within urban areas (e.g. parks, domestic gardens) typically consist of small, highly disturbed or modified patches of vegetation distributed within a matrix of urban development such as buildings and associated infrastructure. Whilst several studies have shown that species diversity for several taxa decreases along the rural-urban gradient (e.g. Sadler *et al.*, 2006; Duchamp and Swihart, 2008), green spaces can nevertheless ameliorate the impacts of urbanisation on biodiversity, and may hold relatively rich wildlife communities (e.g. Chamberlain *et al.*, 2007; Davies *et al.*, 2009). Factors commonly found to influence the abundance and diversity of several taxa (birds,

mammals, invertebrates) include the size, habitat quality and structure of green spaces, although the quality and proximity of suitable habitat in the wider landscape can also be important (e.g. Sadler *et al.*, 2006; Baker and Harris, 2007; Chamberlain *et al.*, 2007). Clergeau *et al.*, (2001) and Angold *et al.*, (2006) argue that appropriate management within areas of urban green space areas can benefit many avian and invertebrate species regardless of the surrounding landscape, and such actions may be far easier to implement. However, the relative importance of local habitat versus the wider landscape is likely to vary markedly between species depending on their ecological requirements and mobility.

#### *Status and conservation of bats in Europe*

There is evidence that many bat species in Europe have undergone large population declines during the 20<sup>th</sup> century, driven by the loss of foraging and roosting habitat. A UK-wide bat survey in the 1990s found that habitats favoured by foraging bats were undergoing rapid rates of loss within the UK, and suggested that this may be limiting bats in some areas (Barr *et al.*, 1993; Walsh *et al.*, 1996). Although it remains the most abundant and widespread bat genus in the UK, estimates from the Annual Bat Colony Survey in the UK suggest a decline of over 60% between 1978 and 1993 for *Pipistrellus* spp. (Hutson, 1993). The species *Pipistrellus pipistrellus* was only recently recognised as two separate species, *P. pipistrellus* and *P. pygmaeus* (International Commission on Zoological Nomenclature, 2003), so it is not known whether this decline has affected both species equally.

In order to sustain bat populations, urban areas need to provide both roosting and foraging sites, and routes which allow bats to commute between the two. Some bat species now commonly use buildings as maternity roosts, and exploit foraging opportunities provided by man made structures such as streetlamps and sewage works that are associated with high insect densities (Rydell, 1992; Altringham, 2003; Park and Cristinacce, 2006). Several studies have suggested that urban environments may have a positive role to play in resource availability for bats (e.g. Avila-Flores and Fenton, 2005; McDonald-Madden *et al.*, 2005; Haupt *et al.*, 2006), particularly in landscapes dominated by

intensive agricultural land use, which studies have repeatedly found are avoided by bats (Walsh and Harris, 1996; Gehrt and Chelvig, 2003). There appear to be marked species-specific responses to urbanisation, however, with other species strongly avoiding built up areas (e.g. Kurta and Teramino, 1992; Waters *et al.*, 1999; Lesiński *et al.*, 2000).

Understanding how different species use urban environments and how habitat management and urban planning can promote population persistence is critical to their conservation. The aim of this study was therefore to identify site-specific and wider landscape features (e.g. woodland connectivity, urbanisation) that influence bat activity within areas of urban green space.

## **MATERIALS AND METHODS**

### *Study sites*

Glasgow is the largest city in Scotland (UK), with the Greater Glasgow conurbation covering an area of 369km<sup>2</sup> with a population of approximately 1.2 million people. Over 20% of the area of Greater Glasgow is green space; including 74 parks and other potentially important features such as river corridors, woodlands, cemeteries and communal gardens (Humphries *et al.*, 2009). Other than two very large sites (>140 ha), green space areas owned by Glasgow City Council (GCC) range from 1.5 – 68.4 ha (mean 18.2). A total of 29 sites owned and managed by GCC were surveyed for bat activity between 31 May and 11 July 2007 (Table 1). Sites were chosen randomly whilst ensuring they were a minimum of 1km apart and spanned a range of sizes (mean 24.3 ± 14.9; range 6.2 – 53.2 ha).

### *Monitoring bat activity*

Point counts were used to quantify bat activity. At each park 10 minute recordings were made at between two and six locations depending on the size of the park (across parks, an average of four point counts were recorded). Each point location was chosen using randomly-generated xy coordinates but omitting areas of open water within the park and ensuring a minimum distance of 30m between points. On each survey night, one of four geographical areas of Glasgow (NE, NW, SE, SW) was chosen randomly, and between one and four parks were surveyed, again in random order, with each park being surveyed once. Within a night, all point counts were conducted within 2 h 15 minutes of each other, the first starting 45 min after sunset. At the start of each count air temperature was measured to the nearest 0.1°C and wind speed was estimated using the Beaufort scale. Counts were only conducted in dry weather where the temperature at dusk exceeded 10°C and the strength of the wind did not exceed Beaufort 3 (since strong winds influence both insect distribution and detectability of bat calls).

### *Sound recording and analysis*

A frequency division bat detector (Batbox Duet, Stag Electronics; frequency response 17-120kHz) was connected to a MiniDisc (Sony MZ-R909; frequency

response  $\pm 3\text{dB}$  20Hz – 20kHz) and a continuous recording made for each point count onto a recordable MiniDisc. Frequency division is a broad-band system that records all frequencies continuously, and is sufficient for distinguishing between the genera *Myotis* and *Pipistrellus*, and between the *Pipistrellus* species (e.g. Vaughan *et al.*, 1997a; see sound analysis). We analysed recordings using BatSound v3.31 (Pettersson Elektronik AB, Uppsala, Sweden), with a sampling frequency of 44.1kHz with 16 bits per sample, and a 512 pt. FFT with Hanning window). One bat pass was defined as a continuous sequence of at least two echolocation calls from a passing bat (Fenton, 1970; Walsh *et al.*, 1996).

Three genera of bat occur in the area where this study was conducted; *Pipistrellus*, *Myotis* and *Plecotus* (Richardson, 2000), although *Plecotus* is rarely recorded due to its quiet echolocation calls. Unfortunately, problems with the recording equipment meant that for all but seven parks (representing 25% of the point counts) recordings were made in mono (heterodyne) rather than stereo (heterodyne and frequency division). Analyses were therefore conducted on the number of bat passes per point count. Terminal feeding buzzes emitted when attempting prey capture were also counted and provide a measure of foraging effort.

#### *Habitat availability within, and surrounding, urban parks*

Habitat structure within the parks was fairly simple consisting largely of a mixture of improved grassland, mixed woodland and shrubs. All but one park had some mixed woodland on site, although there was considerable variation in the amount among parks (0.3 – 45ha). Of the parks surveyed, 21 had still (> 3m width) or running water (> 1m width) present. Habitat within 30m of each recording point was categorised according to the presence of woodland and still or running water. Of 111 point counts made, 31 were adjacent to water (i.e. within 30m), 50 were adjacent to woodland, 12 were adjacent to both water and woodland and 42 were made within grassland with no water or woodland nearby.

The landscape analysis was performed using data from OS MasterMap Topography Layer (Digimap Ordnance Survey® Collection). We used ArcGIS 9.2 to create buffers of 1 km radius around the centre of each park and reclassify the feature classes from the topography layers into five categories (hereafter referred to as habitat classes). These were: 1) urban areas (buildings, structures, roads and parking areas); 2) urban gardens (urban land not covered by buildings or structures); 3) grassland and scrub; 4) woodland (coniferous, deciduous and mixed woodland, and areas covered by scattered trees); 5) water (inland and tidal water). A 6<sup>th</sup> category (called “other”) included features that didn’t fall into any of the 5 previously mentioned habitat classes, but its proportion was less than 4% in all cases. Because the 1 km radius was taken from the centre of

the park rather than the location of individual points, the proportion of the 3.14 km<sup>2</sup> circle that lies outside the park varies between parks, although this variation is relatively small (non-park area: 83–98%). We then used the software package Fragstats 3.3 to calculate a selection of different landscape metrics for each habitat class within the 1 km buffer including the proportion of land covered, the number of patches, mean patch area, largest patch, total edge density, area-perimeter ratio and Euclidean nearest neighbour distance (ENN distance is the shortest straight-line distance between the focal patch and its nearest neighbour of the same class; McGarigal *et al.*, 2002).

The proportions of different habitat categories within a 1km radius of a park are not independent since all must sum to 1. Our purpose for including information about the habitat surrounding each park as potential explanatory variables in the model was to assess how bat activity may be influenced by levels of urbanisation and proximity of habitats considered important for many bat species, for example woodland. We focused, therefore on the proportion of urban and woodland habitat, and the mean ENN distance among water bodies within a 1km radius of the centre of each park. The size of the park was significantly positively correlated with the proportion of woodland within the 1 km buffer ( $t_{27} = 2.70$ ,  $p = 0.012$ ,  $r^2 = 0.21$ ), and % woodland cover was weakly negatively correlated with % urban cover ( $t_{27} = -2.05$ ,  $p = 0.05$ ,  $r^2 = 0.13$ ) but neither of these was sufficiently strong to cause problems with multicollinearity. There was no correlation between % urban cover and the size of the park ( $t_{27} = 0.23$ ,  $p = 0.76$ ,  $r^2 = 0.0019$ ). Percentage woodland and urban cover were arcsine square root transformed prior to analysis.

There are many different metrics that can be calculated to assess the composition and configuration of habitat patches within a landscape, and therefore potentially a great many potential explanatory variables. We minimised the number of potential variables describing the configuration of woodland patches within the surrounding landscape as the proportion of woodland within a 1km radius of each park correlated strongly with several measures commonly used to assess isolation of that habitat (McGarigal *et al.*, 2002). For example, proportion of woodland was strongly correlated with both edge density ( $t_{27} = 4.51$ ,  $p = 0.0001$ ,  $r^2 = 0.43$ ), and weighted-mean ENN distance ( $t_{27} = -3.78$ ,  $p = 0.0008$ ,  $r^2 = 0.35$ ).

#### *Data analysis*

All statistical analyses were conducted using the R computing environment (version 2.8.1, R Development Core team, 2008). To assess the influence of habitat features and the surrounding matrix on bat activity in urban green space, we fitted a Generalised Linear Mixed Effects model with quasi-poisson errors using the number of bat passes at each location ( $n=111$ ), as the dependent variable. The following were included in the starting model as potential explanatory variables:

the presence or absence of a water body or woodland adjacent to each point count (within 30m) were included as fixed factors; the order in which the points were surveyed (i.e. to account for variation of activity with time of night), the proportion of woodland and urban cover, and the mean ENN distance between water bodies within a 1km radius of the centre of the park, the size of park, wind speed, temperature (linear and quadratic terms) were covariates. A two way interaction between park size and each of the landscape metrics was also included. Park was a random factor used as a grouping variable. The model was carried out in a stepwise fashion, with the least significant of the explanatory variables being removed at each step in an effort to determine which of these variables had the most significant effect.

RESULTS

Bat activity

A total of 852 bat passes was detected during 18.5 hours of recording during the study. On average, 14.7% of bat passes had feeding buzzes and evidence of feeding activity was detected at 62% (18/29) parks. There was a significant positive correlation between the number of bat passes and feeding buzzes per park (Spearman rank  $r_{s29} = 0.79$ ,  $p < 0.0001$ ), suggesting that the use of bat passes is a reasonable measure of foraging activity.

For the seven parks (28 point count locations) at which bat passes could be assigned to species level (see Methods), 128 of 160 (80%) of identified *Pipistrellus* passes were attributable to *P. pygmaeus*. Total bat activity within urban parks was significantly higher adjacent to water bodies or areas of woodland; based on differences in the adjusted median values, the presence of water bodies and woodland increased bat activity by a factor of 3.2 and 1.7 respectively (Table 2, Figs. 1 and 2). The final model explained 56% of the variation in activity among point counts. There were no significant interactions between the size of park and the surrounding landscape variables (proportion of urban, proportion of woodland, mean ENN distance between water bodies within a 1km<sup>2</sup> radius around each park), and none of the landscape variables had a significant influence on bat activity on their own.

In this study wind speed correlated positively with bat activity (Table 2) although this relationship is entirely reliant on the data point with the highest bat activity and, if removed, wind speed becomes non-significant. The remaining variables in the model, however, are all retained.

DISCUSSION

The presence of both water bodies and woodland in urban parks resulted in significantly increased bat activity, with the effect of water being the most marked. This is likely to be because the majority of bat passes recorded during these surveys were of *P. pygmaeus* which, of the two most common pipistrelle species in the UK, is particularly associated with

riparian habitats (Vaughan *et al.*, 1997b; Nicholls and Racey, 2006; Sattler *et al.*, 2007). The importance of water bodies within urban green space for birds has recently been highlighted by the Biodiversity In Glasgow project, co-ordinated by the British Trust for Ornithology (Humphries *et al.*, 2009). Between five and 61 bird species were recorded within urban green spaces in Glasgow, with sites containing water bodies having an average of five more species than those lacking water.

Previous studies have shown the importance of deciduous or mixed woodland for foraging bats (e.g. Walsh and Harris, 1996; Johnson *et al.*, 2008), and areas with higher proportions of well connected woodland might have been expected to have had higher levels of bat activity as found by Gehrt and Chelstvig, 2003. In this study, however, although woodland adjacent to recording sites had a positive effect on levels of bat activity (largely *P. pygmaeus*), the amount and connectivity of woodland at a larger scale did not.

Previous work has indicated that species respond differently to urbanisation which, given the marked differences in roosting and foraging ecology among bat species, is not surprising. Gehrt and Chelstvig (2004) found positive associations between urban indices and activity of *Eptesicus fuscus*, *Lasiurus borealis* and *L. noctivagans*. Other species, however, appear to largely avoid urban areas (e.g. *Nyctalus leisleri* – Waters *et al.*, 1999; *Myotis sodalis* – Sparks *et al.*, 2005) or are otherwise sensitive to features associated with urbanisation such as street lighting (e.g. *Rhinolophus hipposideros* – Stone *et al.*, 2009). Duchamp and Swihart (2008) identified two groups of bat species whose populations showed opposite trends along urban and forest gradients. Species that responded negatively to urban development were those requiring tree cavities for roosting and a wing morphology adapted to flight in cluttered environments such as woodland (ie. low wing loading), whereas the opposite was true for species that responded positively to urbanisation. These predictions fit well with our findings for *P. pygmaeus*, the most frequent species recorded during this study, which is commonly associated with building roosts and adapted to flight in relatively open environments. It might be expected that the two *Myotis* spp. commonly found in Scotland would react differently to urbanisation: *M. daubentoni* is also associated with riparian habitats but typically roosts in tree cavities or within the stonework of bridges, and *M. nattereri*, also a tree rooster, forages largely in woodland habitats (Altringham 2003).

Data presented in this study suggests that, for *P. pygmaeus*, the habitat within a site may be more important than the surrounding landscape as Gilbert (1989) suggested may be the case for highly mobile species within urban environments. That the size of park was not an influential factor on *P. pygmaeus* activity suggests that even small areas of urban green space can provide valuable foraging opportunities for bats able to adapt to urbanised landscapes, provided

there is suitable habitat (ie. water bodies and woodland) within the site. For other species, however, a wider landscape-approach, such as increasing woodland cover both within urban parks and in the surrounding matrix to link foraging areas, is likely to be necessary.

### ACKNOWLEDGMENTS

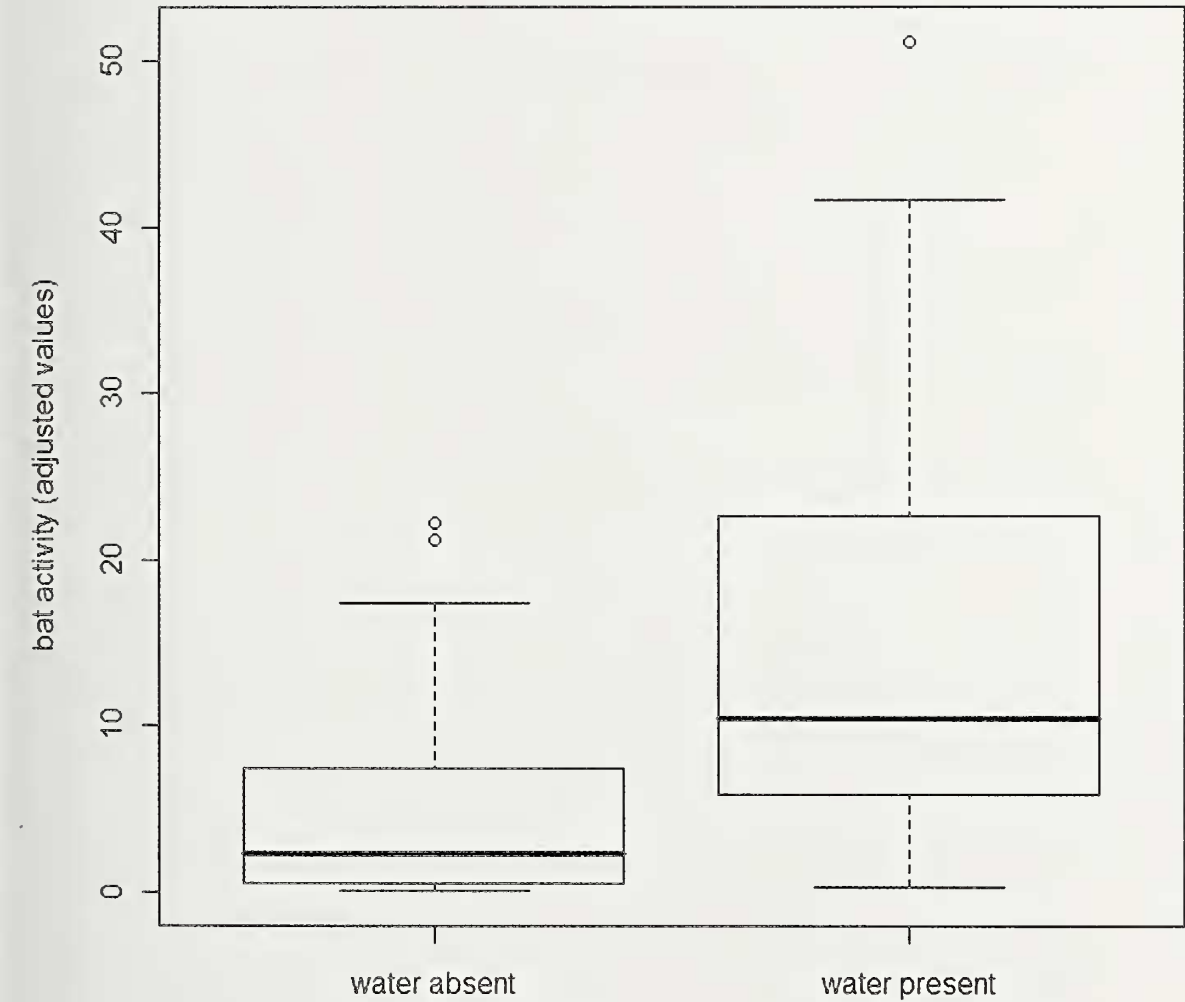
Many thanks to Sheila Russell (Glasgow City Council) for providing information on the sites within Glasgow, Liz Humphreys (BTO Scotland) for information on the BIG project, Kevin McCulloch for field assistance and Mario Vallejo-Marin for statistical advice. This work was funded by the Carnegie Trust for the Universities of Scotland.

Site name	Latitude	Longitude	Size (ha)	Date surveyed	Surrounding habitat		
					% urban	% woodland	Mean ENN distance water <sup>a</sup>
Auchinlea Park	55° 52' 16.96"	-4° 8' 1.81"	29	11/07/2007	24.6	5.5	395.0
Cardonald Park	55° 51' 27.26"	-4° 20' 55.78"	7	18/06/2007	32.6	3.3	57.4
Cardowan Moss Woodland	55° 52' 48.28"	-4° 9' 1.09"	45	10/07/2007	16.2	16.8	57.1
Cleddans Burn	55° 54' 51.80"	-4° 23' 9.14"	15	04/06/2007	14.6	9.4	40.1
Cowlairs Park	55° 52' 42.12"	-4° 14' 46.12"	17	06/06/2007	30.7	2.4	5.6
Cranhill Park	55° 51' 55.55"	-4° 9' 55.72"	10	17/06/2007	24.2	4.8	2.5
Crookston Woods	55° 50' 16.15"	-4° 20' 51.49"	10	09/07/2007	22.2	8.5	5.4
Dawsholm Park	55° 53' 48.65"	-4° 18' 57.62"	33	04/07/2007	24.3	17.8	8.0
Early Braes	55° 51' 5.64"	-4° 8' 9.41"	10	03/07/2007	20.7	4.6	26.9
Elder Park	55° 51' 48.51"	-4° 19' 19.24"	14	18/06/2007	32.4	3.8	129.0
Garseadden Burn	55° 54' 30.84"	-4° 21' 41.44"	23	19/06/2007	23.8	2.8	8.0
Garseadden Woods	55° 55' 9.96"	-4° 21' 26.53"	25	04/06/2007	16.4	7.1	18.5
Glasgow Green	55° 51' 5.25"	4° 14' 34.79"	53	08/07/2007	36.7	4.9	754.8
Hogganfield Park	55° 52' 47.17"	-4° 10' 4.35"	46	17/06/2007	16.6	12.5	40.7
Househill Park	55° 49' 13.64"	-4° 21' 45.20"	23	09/07/2007	18.2	8.8	5.6
Kelvingrove Park East	55° 52' 10.59"	-4° 16' 56.68"	36	18/06/2007	38.0	3.8	11.9
Kings Park	55° 48' 55.95"	-4° 14' 27.34"	28	08/07/2007	19.9	5.4	517.7
Knightswood Park	55° 53' 49.48"	-4° 21' 4.37"	20	04/07/2007	19.7	1.5	11.8
Linn Park	55° 48' 19.13"	-4° 15' 34.17"	50	11/06/2007	18.1	11.4	41.5
Maxwell Park	55° 50' 16.93"	-4° 17' 18.77"	8	10/06/2007	24.5	4.4	134.3
Mount Vernon Park	55° 50' 33.21"	-4° 8' 13.38"	6	03/07/2007	17.4	3.6	25.3
Newlands Park	55° 48' 43.51"	-4° 16' 56.04"	6	11/07/2007	23.3	2.0	84.1
Priesthill Park	55° 48' 39.19"	-4° 20' 45.65"	7	09/07/2007	24.2	7.3	8.0
Queens Park	55° 49' 49.00"	-4° 16' 13.88"	45	10/06/2007	30.7	7.2	129.1
Robroyston Park	55° 53' 24.23"	-4° 11' 44.30"	42	11/07/2007	18.9	2.9	163.4
Sandyhills Park	55° 50' 51.60"	-4° 9' 11.90"	9	03/07/2007	22.0	4.0	18.4
Springburn Park	55° 53' 32.17"	-4° 13' 22.65"	31	06/06/2007	22.7	7.8	49.1
Tollcross Park	55° 50' 56.35"	-4° 10' 49.95"	37	03/07/2007	28.1	7.1	23.8
Victoria Park	55° 52' 29.77"	-4° 20' 1.99"	20	04/07/2007	29.8	4.8	170.4

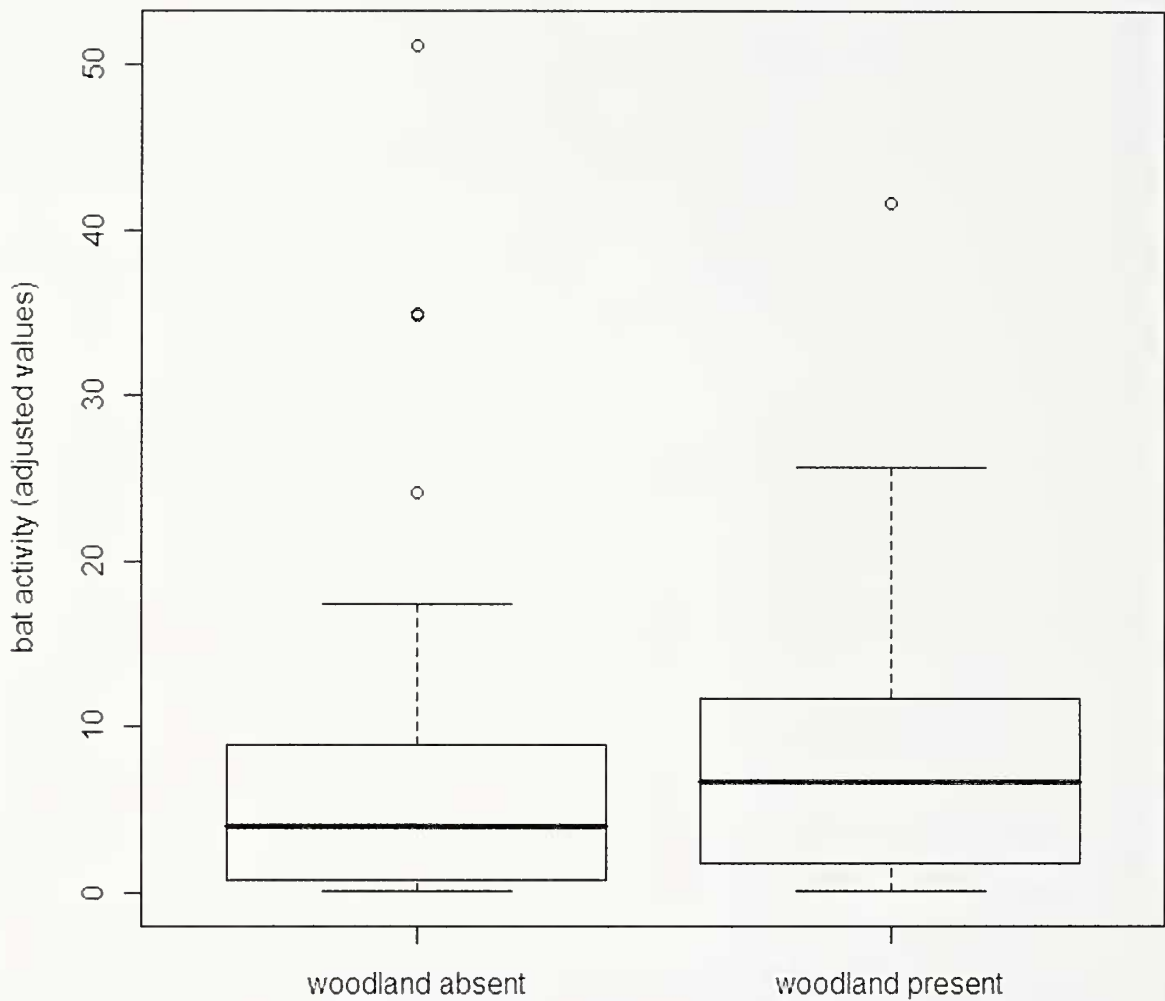
**Table 1.** Locations and attributes of parks visited and the landscape metrics used in the starting model of bat activity. <sup>a</sup> Mean Euclidean Nearest Neighbour Distance between water bodies (ENN distance is the shortest straight-line distance in metres between the focal patch and its nearest neighbour of the same class).

Source	Degrees of freedom	Parameter estimate	Estimate Standard Error	t value
Adjacent water	1	1.699	0.276	6.613 ***
Adjacent woodland	1	0.383	0.268	1.430 ***
Wind speed	1	0.389	0.260	1.496 ***
Temperature	1	-2.098	0.936	-2.242 ***
Temperature <sup>2</sup>	1	0.058	0.0288	2.017 ***
Survey order	1	-0.207	0.103	-2.019 ***

**Table 2.** Generalised linear mixed-effects model for the effects of habitat and weather variables on bat activity within urban parks in Glasgow City ( \*\*\*  $p < 0.0001$ ). The sign and size of the parameter estimate (and the error) are used to assess the relative magnitude of the effects of these variables on bat activity.



**Fig. 1.** Adjusted total bat passes at ten-minute point counts adjacent ( $n=31$ ) and not adjacent ( $n=80$ ) to water bodies. Values shown are those corrected for explanatory variables in the final model (Table 2). Tukey box plots are used here with boxes representing the location of the middle 50 percent of the data and the upper and lower quartiles, and the whiskers 1.5 x the interquartile range.



**Fig. 2.** Adjusted values of total bat passes at ten-minute point counts adjacent ( $n=50$ ) and not adjacent ( $n=61$ ) to woodland. Values shown are those corrected for explanatory variables in the final model (Table 2). Tukey box plots are used here with boxes representing the location of the middle 50 percent of the data and the upper and lower quartiles, and the whiskers 1.5 x the interquartile range.

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## Urban Biodiversity: Successes and Challenges: Parklife; cities for people and nature

Scott Ferguson

Scottish Natural heritage

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Some have argued that suburban gardens are England's most important nature reserve. Can that be true for Scotland too? From the butterfly on the buddleia to the raven nesting on the gas-tower, there is no doubt that the mosaic of habitats across urban areas support an amazing array of wildlife – and offer a wealth of opportunities for people to enjoy, learn about and celebrate that diversity.

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## Urban Biodiversity: Successes and Challenges: Cities deserve landscape-scale wildlife spectacles

Stuart Housden

Royal Society for the Protection of Birds Scotland

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In such uncertain financial times it is heartening to recognise that the policy framework for delivering large scale habitat creation projects in Scotland has never been more positive. This is a recognition that these types of projects have been delivered elsewhere in the UK bringing with them not just a huge boost to biodiversity but a whole brigade of associated benefits.

Whether you are interested in education, climate change, flood alleviation, economic growth, creating a pleasant environment for people to live and work, direct employment or improving the social esteem of previously marginalised communities there is little doubt that investment in landscape scale environmental projects in an urban setting can and should make a significant contribution to the future of Scotland.

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## Urban Biodiversity: Successes and Challenges: A tactical approach

Malcolm Muir

Countryside and Greenspace Manager, South Lanarkshire council

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The quality of urban open spaces can have a significant effect on their neighbouring communities. They offer opportunities for play, healthy recreation, sustainable transport and biodiversity and may indeed be the key to effecting a transformation in public understanding for and engagement with the natural heritage in Scotland. The eco-system approach rightly advocates acceptance of change, decentralisation and the participation of all sectors of society. Greenspaces, largely owned by Local Authorities offer the perfect test bed for this approach and the opportunity to clearly demonstrate to policy makers the links between environmental quality, health and economic and social well being. The current financial "crisis" actually presents a window of opportunity for this area of work but, despite these opportunities, real challenges remain; many of them linked to fundamental public service processes and "mind sets", and these will not be overcome through legislation alone.

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## **Urban Biodiversity: Successes and Challenges: Glasgow's Freshwater Fishes – the State of the Cart (and other urban watercourses)**

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The Clyde River Foundation (CRF) is a registered charity which researches the ecology of the River Clyde and its tributaries, and promotes environmental education throughout the catchment. Glasgow's freshwater fishes are surprisingly poorly known, despite the well-publicised renaissance of the local watercourses and the iconic nature of the salmon in Glasgow folklore. Our current knowledge of the fish communities of the major rivers: the Clyde, Kelvin, White Cart and North Calder will be described, together with a summary of the findings from a recent survey of Glasgow's burns.